Pamphlets on forestry in Iowa.

FORESTRY PAMPHLETS

Iowa

Vol. II.

1 Comparative Values of Alcohol and Gasoline for Light and Power. Bulletin 93, Iowa Agricultural Experiment Station.

2 Future Forestry in Iowa. Bulletin 4, Dept. of Forestry, Iowa State College.

3 Planning and Adorning the Farmstead. Bul. 126, Iowa State College Agri. Exp. Sta.

4 Evergreen Trees for Iowa. Bul. 170, Iowa State College Agricultural Exp. Station.

5 The White-Marked Tussock Moth. Cir. 33, Iowa State College Agri. Exp. Station.

6 Renewing the Shelterbelt. Cir. 27, Iowa State College Agri. Experiment Station.

7 The Ames Forester, Iowa State College, 1916.

8 The Ames Forester. Iowa State College, 1917.

9 Admission and Courses of Instruction. Iowa State College of Agriculture, Ames, Iowa, Vol. XV, No. 35, May 1, 1917.

10 General Catalogue. Iowa State College of Agriculture. Vol. XV, No. 32, April 1, 1917. Ames, Iowa.

11 Opportunity Comes Again. Iowa State College of Agriculture, Vol. XVI, No. 22, Oct. 31, 1917.

BULLETIN 93 JULY, 1907

EXPERIMENT STATION

IOWA STATE COLLEGE

OF AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL ENGINEERING SECTION

COMPARATIVE VALUES OF ALCOHOL AND GASOLINE FOR LIGHT AND POWER

AMES, IOWA

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COMPARATIVE VALUES OF ALCOHOL AND GASOLINE FOR LIGHT AND POWER.

J. B. DAVIDSON M. L. KING

In the spring of 1906 the National Congress passed an act which became a law January 1, 1907, permitting the withdrawal from bond, tax free, of domestic alcohol, when denatured or rendered unfit for a beverage by the addition of certain materials repugnant to the taste and smell. A portion of this act reads as follows:

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That from and after January first, nineteen hundred and seven, domestic alcohol of such degree of proof as may be prescribed by the Commissioner of Internal Revenue and approved by the Secretary of the Treasury, may be withdrawn from bond without the payment of internal revenue tax, for use in the arts and industries, and for fuel, light and power provided said alcohol shall have been mixed in the presence and under the direction of an authorized Government officer, after withdrawal from the distillery warehouse, with methyl alcohol or other denaturing material or materials, or admixture of the same, suitable to the use for which the alcohol is withdrawn, but which destroys its character as a beverage and renders it unfit for liquid medicinal purposes; such denaturing to be done upon the application of any registered distillery in denaturing bonded warehouses specially designated or set apart for denaturating purposes only, and under conditions prescribed by the Commissioner of Internal Revenue with the approval of the Secretary of the Treasury."

The new law has aroused no little interest concerning the use of alcohol for fuel and light and not only has the Experiment Station been called upon to answer many inquiries, but also the subject has received much attention in the current literature of the day. The opinions advanced in these articles differ very much, and the fact has been made plain that very little reliable data concerning the subject is available. The Agricultural Engineering Section has for some time been conducting experiments to learn something of the value of this fuel for lamps and internal combustion engines, and this bulletin contains the results of the experimental work completed to date.

The alcohol used in these tests was grain or ethyl alcohol of approximately 188 proof or 94% purity by volume and was not

denatured. The gasoline was obtained from a local tank line and was the kind sold for stove and engine fuel.

The experimental work undertaken with alcohol and gasoline was for the purpose of making a comparison between (1) the heat value of the fuels, (2) their economy in the production of light, (3) their economy in the production of power, and (4) the relative safety of alcohol and gasoline for general use.

CALORIMETER TESTS.

Definition of the British Thermal Unit (B. T. U.)—The British thermal unit is defined as the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. This value is definite enough for most practical purposes, however, in order to be precise, this one degree of rise is specified as being from 62 degrees to 63 degrees Fahrenheit. This is due to the fact that the specific heat of water varies somewhat at different temperatures.

Description of Calorimeter.—The calorimeter used is one known as the Parr Standard Calorimeter which is of the bomb type and is provided with an electric igniting device. The oxygen for supporting combustion in the bomb is furnished by sodium peroxide. A special accelerator composed of two parts of boric acid and one part potassium nitrate is used with the fuel. When making the tests the proper corrections were made for the heat of the accelerator and other chemical reactions, also the water equivalent of the instrument. Each determination was continued long enough to determine the rate of transfer of heat to the air, and the readings of the rise in temperature corrected accordingly. These separate calibrations were necessary because it was found impossible to keep the temperature of the room constant.

Method of Weighing Fuel.—The directions for using the calorimeter state that when liquid fuels are tested the weight of fuel used may be obtained by using a weighing flask with a dropper tube in the stopper. This method would not cause a perceptible loss in the case of heavy oils, but alcohol or gasoline is so volatile that the following method was resorted to. Small glass bulbs with a capillary tube attached were blown, weighed, filled with fuel, sealed and reweighed. Thus all losses by vaporization were prevented while reweighing and closing calorimeter. The glass of the bulb being inert did not in any way effect the results.

Heat Produced by the Union of Water and Sodium Peroxide.—As stated the alcohol contained about 6 per cent. of water by volume. This water reacts with the sodium peroxide generating heat rapidly enough when placed in the calorimeter to cause the charge to ignite at once. The rapidity of this action was prevented

by breaking only the capillary tube, leaving the bulb intact. When the bomb was closed, it was shaken gently allowing the alcohol to leave the bulb slowly. Thus the heat generated was given time to be absorbed by the apparatus without raising any portion of the charge to the ignition point. The bulb was finally broken by violently shaking the bomb and the whole was placed in the calorimetric bath and constant conditions of temperature obtained before igniting.

Higher and Lower Heat Value.—In the combustion of gasoline or alcohol the hydrogen of the fuel unites with oxygen forming water. If this water passes off in the form of steam, it retains its latent heat of vaporization. At atmospheric pressure the latent heat of water amounts to 965 B. T. U. per pound. In determining the heat value of such fuels by the type of calorimeter used, the water is retained and condensed, thus causing it to give up its heat of vaporization. Results obtained in this way are termed the higher heat values while the results of tests permitting the moisture to pass off in the form of steam are termed the lower heat values. The higher value is more often quoted, but the lower value is the value more nearly realized in practice. In the following table the higher heat values were obtained by tests while the lower heat values were calculated from the higher values.

In the case of alcohol the heat of vaporization of not only the water produced by combustion, but also the water originally in the alcohol was substracted from the higher value to obtain the lower value since this water must be converted into vapor or steam and pass off as such.

For each value tabulated three satisfactory consecutive determinations were made, and the two more nearly agreeing were averaged.

TABLE NO. I

HEAT VALUES

FUEL	% Purity by Volume	Spec. Grav.	Degree Baume Scale	Higher Heat Value		Lower Heat Value	
				B. T. U. per Pound	B. T. U. per Gallon	B. T. U per Pound	B. T. U. per Gallon
Gasoline	93.67	7289	62.027	20060	121864*	18548	113285
Alcohol		.8212		12200	83521	10977	75124

*Lighter gasolines may have a heat value of 117000 or less.

Basing the "higher heat" value of gasoline as to weight and volume on 100%, it is to be noted from this table that the value of alcohol is 60.8% and 68.5 respectively, which is to say that on the same basis alcohol is 39.2% lower than gasoline by weight and 31.5% lower by volume than gasoline. It is further to be noted that the "lower heat value" for alcohol is 59.2% by weight and 66.4% by volume of the "lower heat value" of gasoline. Attention is called to the fact that unless a greater thermal efficiency can be secured in the use of alcohol in lamps and internal combustion engines, its consumption must necessarily be much greater.

The reason for the difference in heat values of gasoline and alcohol may be explained quite easily from a chemical standpoint. Gasoline is composed almost entirely of bodies belonging to an important series of compounds known as the paraffine series. This series has many derivatives such as its nitrogen, sulphur, and oxygen derivatives. The alcohols are a class of the oxygen derivatives of which ethyl alcohol is a member. In other words the alcohols may be said to represent the first stage of oxidation of the corresponding members of the paraffine series.

*Composition of Fuels.**—The crude petroleums of the United States are largely made up of bodies of different densities composing the paraffine series. All these oils contain twice as much hydrogen plus two parts, as carbon and are represented by the general formula $C_n\ H_{2n+2}$ where n may be any number from 1 to 32. The lower values of n represent gases while the higher values represent successively gasoline, napthas, kerosene, heavier illuminating oils, lubricating oils of different grades and finally paraffine. It is stated by good authority that gasoline often contains bodies differing in formula from $C_5\ H_{12}$ to $C_8\ H_{18}$ The heavier ones or those of higher carbon content were formerly sold as napthas, but under present market demands are included in gasoline; in fact most of the gasoline used in these tests was of such density as corresponds to C_8H_{18}

The same series, with the addition of one part of oxygen, represents the class of derivatives known as the alcohols the general formula for which is $C_n\ H_{2n+2}\ O$. The first in the class is wood or methyl alcohol $C\ H_4\ O$ or as it is more often written $C\ H_3\ O\ H$, grain or ethyl alcohol is next $C_2\ H_5\ O\ H$, followed by others the first few of which are usually distilled in small amounts with grain alcohol. The heaviest of the class is bee's wax $C_{30}H_{61}\ O\ H$.

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*The authors wish to acknowledge valuable assistance in the way of suggestions and the loan of apparatus by Professors L. G. Michael and W. F. Coover, Agricultural Chemists at Iowa State College.

The ratio of the heat value of carbon to hydrogen is about as seven to thirty, and alcohol has a higher ratio of hydrogen to carbon than gasoline. For this reason alcohol would have a slightly higher heat value were it not for the oxygen present in the compound. But on account of this oxidation which has taken place the alcohol generates less heat than does gasoline.

TABLE II.

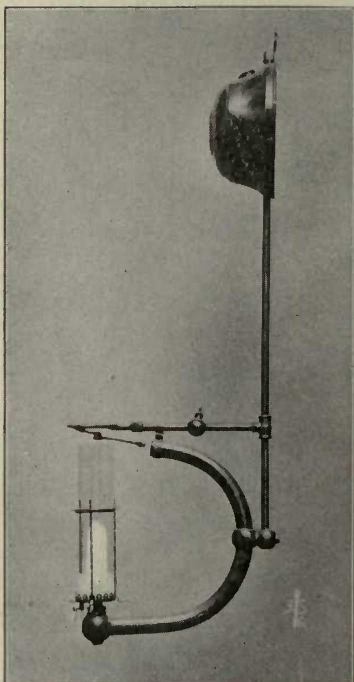
CONSTITUENTS OF ONE GALLON OF FUEL.

	Gasoline	Alcohol
Water	None	65 lbs.
Carbon	5.10 lbs.	3.23 "
Hydrogen	97 "	.82 "
Oxygen	None	2.15 "
Total	6.07 "	6.85 "
Combustible Material	6.07 "	4.05 "
Percent of Combustible Material Realized in Test	90 7	85.3

It is to be noted that the amount of combustible material in one gallon of alcohol is much less than the amount in one gallon of gasoline.

LAMP TESTS.*

The lamps were tested for their horizontal candlepower upon a standard Reichsanstalt photometer fitted with a flicker screen, in the photometer room of the Department of Electrical Engineering of the Iowa State College. The standard used was one of several regularly used for photometric testing by that depart-



[illegible] Lamp No. 1—Operated successfully with alcohol and gasoline.

ment, and, after the tests were completed, it was sent to an electrical standardizing laboratory for calibration and was found to be accurately rated.

A flicker screen was used on account of the difference in color of the lights given off by the mantle and the standard lamp. By means of the flicker screen the two colors were blended, but a

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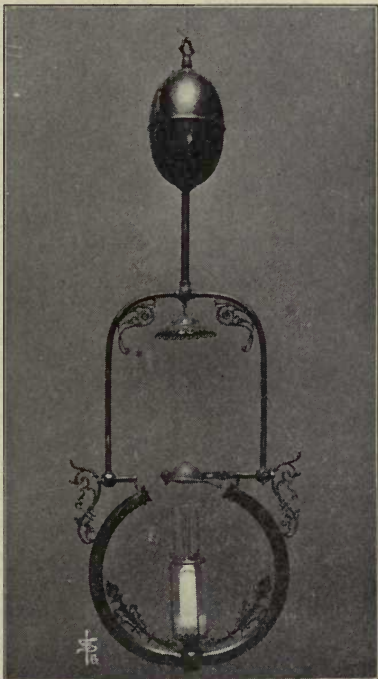
*The Agricultural Engineering Section wishes to acknowledge the valuable assistance in the lamp tests rendered by the Department of Electrical Engineering, Iowa State College, the Sun Vapor Street Light Company, the Best Street Light Company of Canton, Ohio, and Mr. A. B. Cox, representing the Pitner Pressure Lamp of Chicago, Illinois.

difference in intensities of lights remained perceptible. The flicker photometer screen is considered by some good authorities to be susceptible of more accurate reading than any other.

The general appearance and features of the lamps used in the tests are shown in the various illustrations. Lamps Nos. 1, 2 and 3 are gravity lamps each using a clear pearl glass chimney 1⅞x8 inches and a four-inch mantle with 3¼ inches of the mantle exposed to heat.



Lamp No. 2—Operated successfully with alcohol and gasoline.

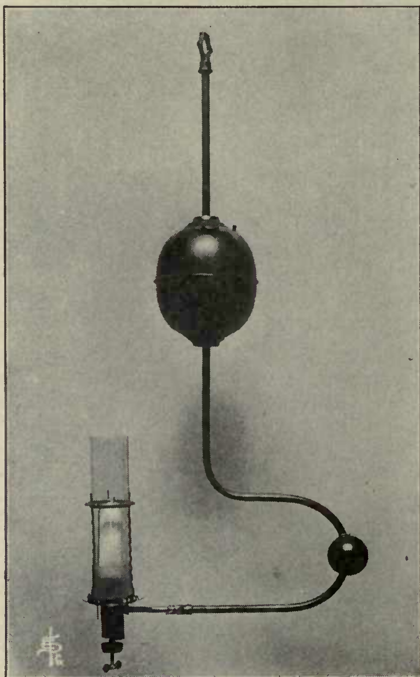
Lamp No. 1 was an over-head generator and had an average fuel head of 15½ inches measured from center of generator to center of tank. The tube in which the fuel was gasified was coiled over the chimney.

Lamp No. 2 was also an over-head generator, had a fuel head of 21 inches and a straight generator tube provided with a hood which seemed to aid in the absorbtion of heat by the generator tube.

Lamp No. 3 was an underneath generator with a fuel head of

about 16 inches. This lamp would not generate or vaporize alcohol.

Lamp No. 4 was a wick gasoline lamp using same chimney and mantle as Nos. 1, 2 and 3. The fuel was conducted upward from the reservoir, by a wick, into a tube 5-16 inches in diameter. This tube terminated in a small opening at the top and was heated by conduction through a copper rod which extended upward intothe flame within the mantle. In this way the heated tube vaporized



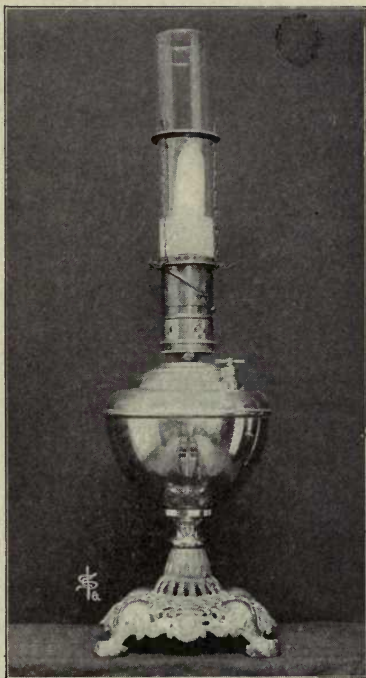
Lamp No. 3—Operated successfully with gasoline but not with alcohol.

the gasoline from the wick, generating sufficient pressure to force the proper amount of fuel up through the opening in the end of the tube to fill the mantle. There seems to be no reason why the copper heat-conductor could not be so designed as to conduct enough heat downward to evaporate the alcohol, but with the lamp tested, alcohol could not be generated or vaporized.

Lamp No. 5 was a pressure over-head generator lamp receiving its fuel through a hollow wire under pressure. This lamp

used a 5-inch mantle, 4⅜ inches of which was exposed to heat supported upon a magnesia post in center of mantle. Four series of carefully conducted tests were made upon this lamp, and curves were plotted representing the data obtained in each series.

Two complete series of tests with each fuel were made with Lamp No. 5 varying the pressure in the fuel supply tank. The results of these tests are shown graphically in Plates I. and II. In the first series of tests, an opening was used in the nozzle of

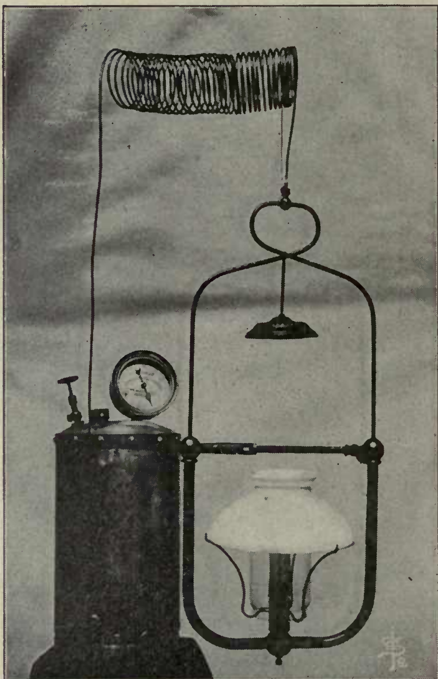


Lamp No. 4—Wick gasoline lamp. Did not operate well with alcohol, but no doubt could be altered to use alcohol successfully.

the generator of such a size as to give an excess of fuel at 16 pounds pressure. In the second series of tests with gasoline, as shown in Plate II., the lamp was provided with a nozzle of such a size as to give an excess of fuel at 36 pounds pressure. In the alcohol test it was found impossible to generate as much fuel as could have been burned in the mantle. This is due to the fact that alcohol requires more heat for vaporization, and hence will

need a special lamp for high pressures. This explains the poor showing made by alcohol at high pressures as indicated by the curves.

A single test with a larger opening in the end of the generator tube and a hood to aid in generation gave 3505 candle power hours per gallon of alcohol at 33 pounds pressure as shown in Plate III. This shows graphically the maximum number of

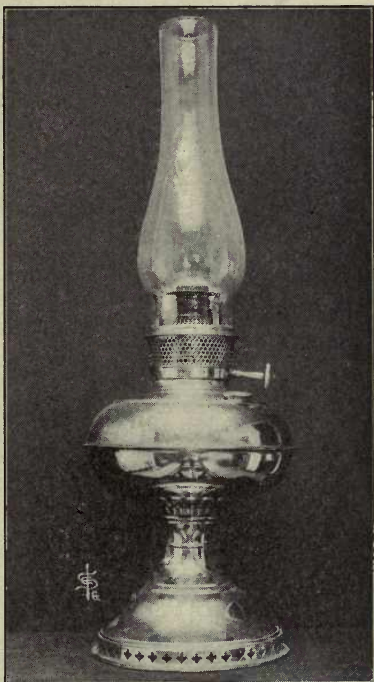


Lamp No. 5—A pressure lamp which operated successfully with alcohol and gasoline. This lamp, as all others, was tested without a shade.

candle power hours per gallon of fuel obtained with each lamp tested.

Mention is to be made of the fact that the lamps using gasoline or alcohol produced a hissing noise which, however, was not objectionable in any case except with Lamp No. 5 with high pressure on fuel tank. Even this would not be noticed in factories and around machinery.

A test was made of a kerosene lamp (No. 6) having a B & H burner with an inch and a half circular wick. This was to make possible a comparison between the mantle lamps and the common wick lamp using kerosene which is probably the most general illuminant for isolated dwellings.



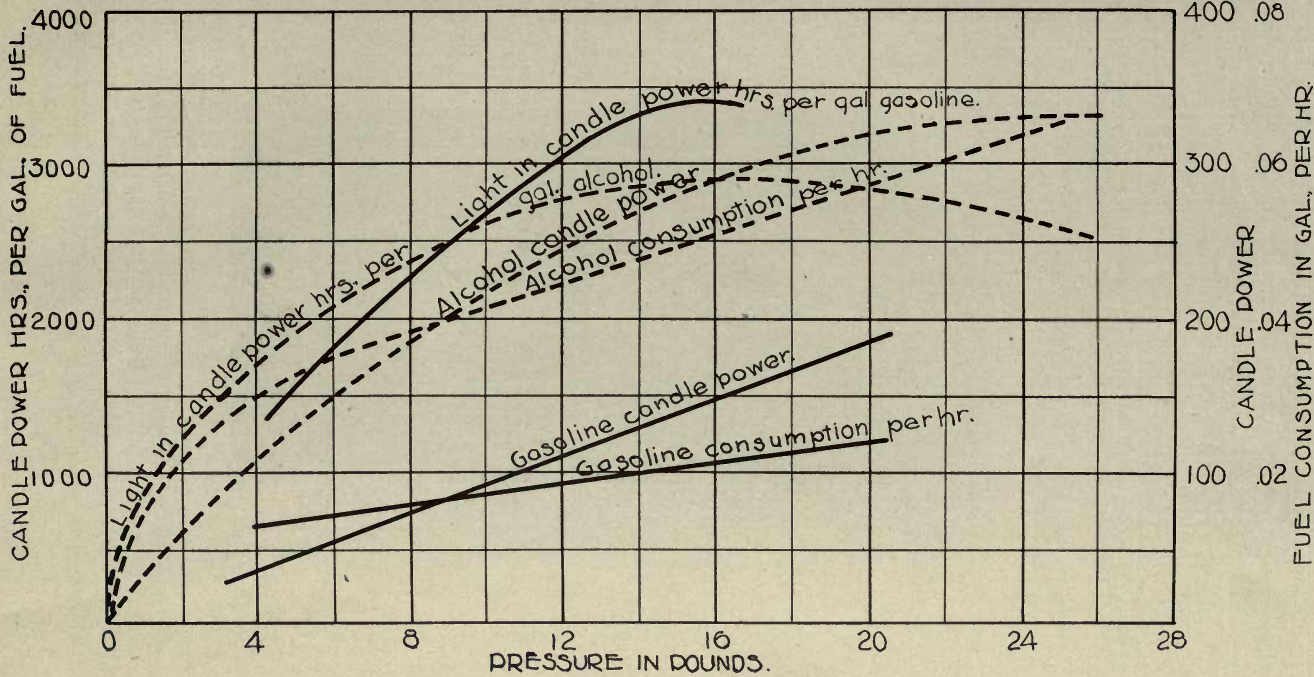
Lamp No. 6—Kerosene Lamp.

TABLE NO. III.

LAMP TESTS.

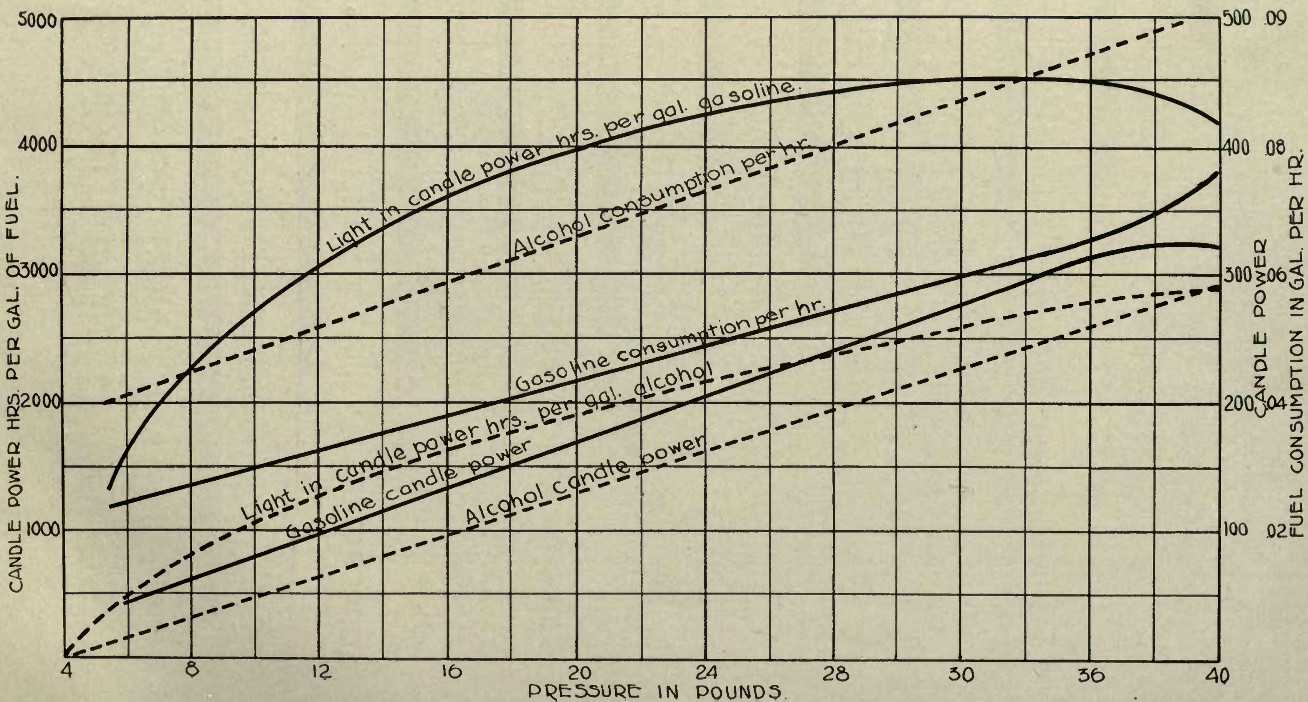
Lamp No.	Fuel used	Duration of Test	Amt. of Fuel Used in Lbs.	Candle Power Developed	C. P. Hrs per Pound	C. P. Hrs. per Gallon
1	Alcohol	2 Hours	.53	62.0	234.1	1571
2	"	2 "	.79	90.6	229.3	1750
2	"	2 "	.59	87.8	255.4	1657
1	Gasoline	3 "	.31	51.2	495.1	2948
2	"	2 "	.245	65.5	534.	3180
5 at 34 lbs.	"	½ "	.202	300.	749.	4550
5 at 33 lbs.	Alcohol	½ "	.318	326.	512.5	3505
5 at 16 lbs	Gasoline	½ "	.131	147.	560.5	3400
5 at 16 lbs.	Alcohol	½ "	.341	290.	425.6	2920
6	Kerosene	2 "	.26	33 5	129.	877

PLATE NO. I



CANDLE POWER HRS., PER GAL. OF FUEL.
4000
3000
2000
1000
0
4
8
12
16
20
24
28
PRESSURE IN POUNDS.
400 .08
300 .06
200 .04
100 .02
CANDLE POWER
FUEL CONSUMPTION IN GAL., PER HR.
Light in candle power hrs. per gal. alcohol.
Light in candle power hrs. per gal gasoline.
Alcohol candle power
Alcohol consumption per hr.
Gasoline candle power.
Gasoline consumption per hr.

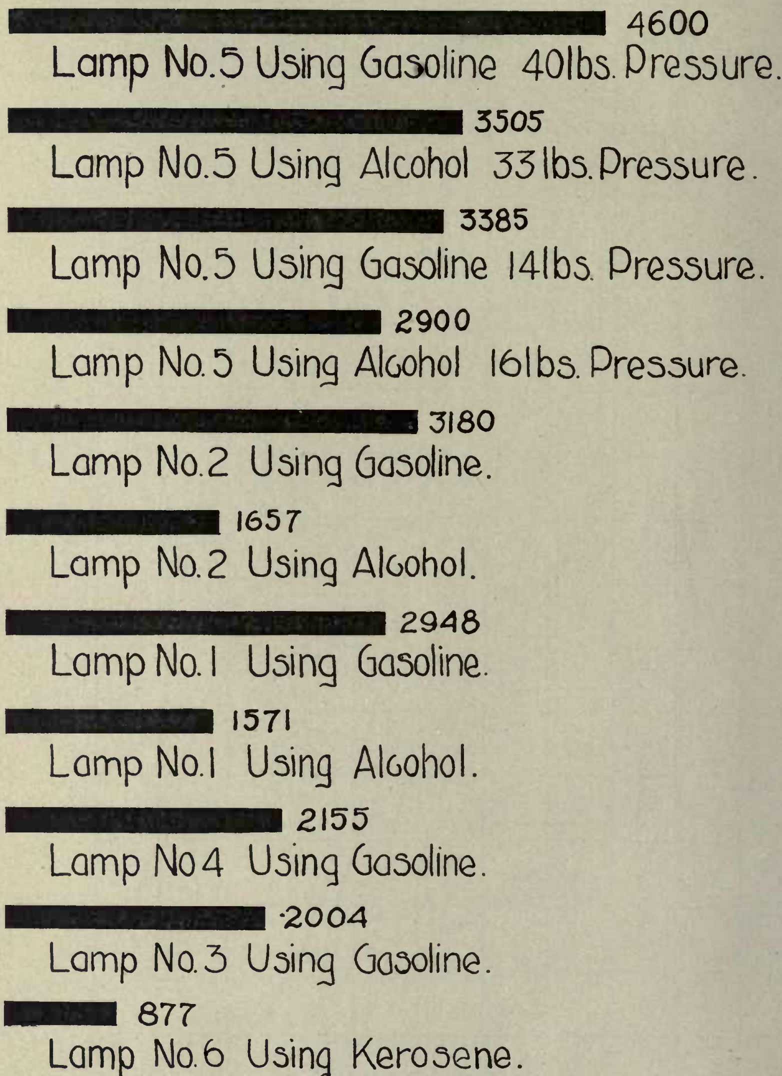
PLATE NO. 2



CANDLE POWER HRS. PER GAL. OF FUEL.
5000
4000
3000
2000
1000
Light in candle power hrs. per gal. gasoline.
Alcohol consumption per hr.
Gasoline consumption per hr.
Light in candle power hrs. per gal. alcohol
Gasoline candle power
Alcohol candle power
4
8
12
16
20
24
28
30
36
40
PRESSURE IN POUNDS.
500 .09
400 .08
300 .06
200 .04
100 .02
CANDLE POWER
FUEL CONSUMPTION IN GAL. PER HR.

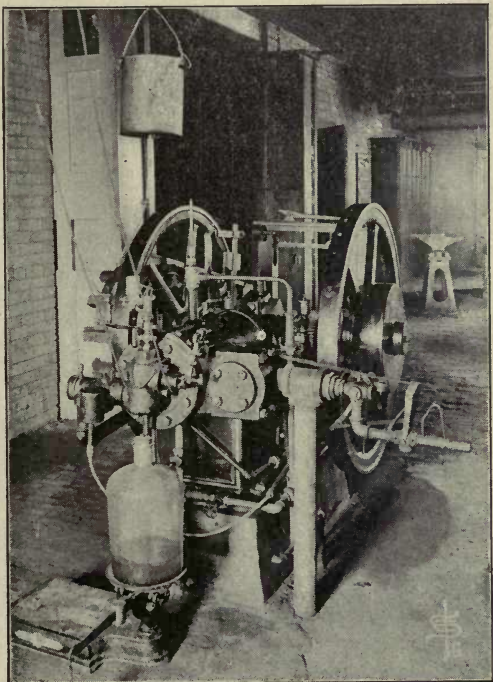
PLATE NO. 3

CANDLE-POWER HOURS PER GALLON OF FUEL



ENGINE TESTS.

Tests were made with three different makes of gasoline engines having ordinary compression pressures, each of which are in general use throughout Iowa. These tests were not as exhaustive as might have been desired from several standpoints, but a further continuation of the tests was not deemed advisable because the Section was unable to secure an engine designed specially for alcohol. And it was further found practically impossible to prop-



Engine No. 1. Used in the Engine Tests.

erly alter the design, of any of the larger gasoline engines found in the laboratory, for the most advantageous use of alcohol.

But the work was carried far enough to show that alcohol probably would not come into successful competition with gasoline in the production of power, when the cost of alcohol per gallon is greater than that of gasoline, even in the special designed engine. Conditions under which alcohol will be able to compete

with gasoline will come about slowly and by the time such conditions exist, the Section expects to have secured enough experimental data upon which to base another more definite and technical bulletin.

The main series of tests were made upon Engine No. 1,* an eight horse power, four cycle, water cooled horizontal engine using a make and break igniter. A complete thermal efficiency test was not made. The temperature of the jacket water was taken merely to determine the condition under which the engine was working, but the amount used was not determined.

The brake horse power was determined by means of a Prony brake and a speed indicator, and the indicated horse power by the number of explosions and the area of the indicator cards. A device was designed for counting the number of charges exploded in the engine. Indicator cards were the means of determining the proper timing of all events of the cycle, and were taken quite frequently to determine the least opening of the fuel valve which would give a full card with high maximum pressure. The point of ignition was such as to give greatest area to indicator card. That is, the maximum pressure from the explosion of fuel was brought about at such a time as to give the line, showing the rise in pressure, a forward inclination of about 4 or 5 degrees † Igniter mechanisms of different designs require such variable lengths of time to act that the point of release of this mechanism is of little value.

Engine No. 2 was similar to No. 1 except that it was of the vertical type and rated at three horse power.

Engine No. 3 was a two horse power, two cycle, water cooled horizontal engine using a jump spark ignition.

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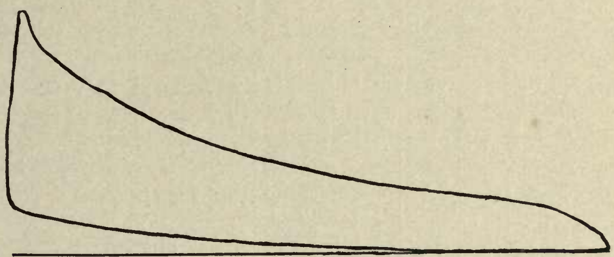
*Valuable assistance with the engine tests has been rendered the Section by the Lennox Machine Co., of Marshalltown, Iowa, for which we desire to express our appreciation.

†Gas Engines by F. R. Hutton.

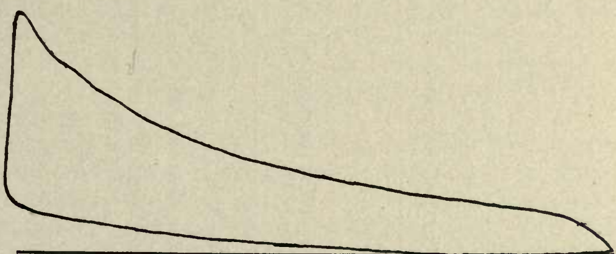
TABLE IV.

ENGINE TESTS.

Engine No.	Kind of Fuel	Indicated H. P.	Brake H. P.	Gallons per Brake H. P hr.	Cost per H.P. hr. at 20c p'r Gal	Compression Pressure
1	Gasoline	11.6	8.6	.142	.0284	51
1	Alcohol	11.6	8.6	.214	.0428	51
1	Gasoline	7 4	5	.18	.036	51
1	Alcohol	7 6	5.1	.241	.0482	51
2	Gasoline		3.27	.167	.0334	60
2	Alcohol		3.25	.226	.0452	60
3	Gasoline		2	.211	.0422	62
3	Alcohol		2.	.284	.0568	62



Indicator card from Engine No. 1 using gasoline. 200 pound spring. M. E. P. 85.



Indicator card from Engine No. 1 using alcohol. 200 pound spring. M. E. P. 85.6.

Note: The gas engine indicator is an instrument for recording the pressures in the engine cylinder at all points to fthe stroke of the piston. The indicator cards or diagrams shown above are samples of the cards obtained by a gas engine indicator during the tests.

TABLE V.

THE AMOUNT OF AIR REQUIRED FOR COMBUSTION

Cu. ft of[1] Air per	Grain Alcohol	Wood Alcohol	Denatured Alcohol	Gasoline	Kerosene[3]
Pound of fuel	98.9	71.1	96 4	166.3	164.3
Gallon of fuel	676.	489.	661.	1008.	1117.
1000 B T. U.	8 92	8.72[2]	8.88	8.96	
1000 C. P. Hrs. with Max. economy with lamp	233.			219.	1267.
1000 C. P. Hrs. with Min. economy with lamp	430.			502.	1268.

[1]Air was taken as weighing .08074 pounds per cubic foot, "Kent."

[2]Jones' Elements of Physical Chemistry.

[3]Kerosene is made up of several compounds, but the specific gravity of the kerosene used corresponds to that of $C_{14}H_{30}$, therefore the kerosene was considered as such.

RELATIVE AMOUNTS OF AIR USED.

The amount of air consumed by different illuminants has recently received considerable attention and the subject is of great importance, for houses are not as a rule, too well ventilated. The fuels are of such a nature that the relative amount of air consumed per pound or per thousand candle power hours, as shown by our tests, may be calculated quite accurately. Gasoline is made up of several slightly different oils; and different gasolines may differ considerably in density, etc., but they differ only slightly in the amount of air consumed per pound (not more than 2% from lightest to heaviest gasoline) and vary in a like manner in the amount of heat given off. Therefore, for any gasoline the amount of air consumed per B. T. U. will not vary more than 1%. With alcohol the variation is greater. Wood alcohol requires about 72% of the amount of air required per pound for grain alcohol, but generates about 77% as much heat per pound as grain alcohol, therefore the amount of air used per B. T. U. is for wood alcohol only 93% of same amount for grain alcohol. As the ingredients of denatured alcohol, as specified by the Rules and Regulations governing the denaturing of alcohol, are one hundred parts grain alcohol, ten parts wood alcohol and one-half of one part benzine, the amount of air required for the combustion of the same may be calculated very closely. The amount of air required for kerosene will also be included in the table.

SAFETY.

The relative danger from fire connected with the use of these two fuels may be considered in two ways: (1) The flash point or temperature at which the fuel vaporizes sufficiently to form an explosive mixture at a certain distance from the exposed surface, (2) the relative difficulty of extinguishing the flame of either while burning.

Flash Point.—The flash point is determined by various methods, but perhaps the method most widely used in the United States is the one specified by the Iowa State Board of Health, and which was followed in the tests upon these fuels. The flash point as determined by these rules is the lowest temperature at which sufficient vapor is given off to be ignited by a small flame, whose greatest dimension is less than ¼ inch, passed over the surface of the oil at a distance of ⅜ inch. The lowest flash point allowed by the State Board of Health for illuminating oils burned from the exposed end of a wick is 105 degrees F.

94% Alcohol flashed at 58.5 degrees F.
90% Alcohol flashed at 58+ degrees F.
64° B. Gasoline flashed at 15.4 degrees F.

This same comparison was made in a different way. The fuels were maintained at the same temperature, 79 degrees F., and the same amount of surface exposed to air, and were tested to find how near a small flame could be brought to the surface of each before the vapor ignited, care being taken to prevent drafts. The average distance for gasoline was 1 7-16 inches, and for alcohol was 1 inch. These tests indicate greater safety in the use of alcohol. This fact must not encourage carelessness, but should simply be taken to indicate that less danger is involved in the use of alcohol than in the use of gasoline.

EXTINGUISHING THE FLAME

The best and about the only practical method of extinguishing a gasoline flame is to smother it, and this is often impossible on account of there being nothing at hand for the purpose. A gasoline flame cannot be extinguished by applying water, for the gasoline will float and the use of water simply spreads the flame.

With alcohol these conditions are reversed as the alcohol flame is more easily extinguished, due to the fact that alcohol vaporizes less rapidly, and also to the fact that alcohol and water mix in all proportions which raises the flash point of the alcohol.

The following mixtures of alcohol and water were made and tested as to their inflammability:

TABLE VI.

INFLAMMABILITY OF ALCOHOL.

No.	% Purity	
1	94	Flashing point below room temperature 70 degrees. Flame steady.
2	90	" " " " " " " " "
3	85	" " " " " " " " "
4	80	" " " " " " " Less "
5	75	" " " " " " " " "
6	70	" " " " " " " " "
7	65	Burned quite readily but would not flash at room temperature.
8	60	" " " " " " " " " "
9	50	" " " " " " " " " "
10	40	" " " " " " " " " "
11	30	Did not ignite until warmed to about 110 degrees F.
12	20	Heated nearly to boiling point before it could be ignited.

The first six solutions above flashed at room temperature 70 degrees F. The richer solutions, however, burned very freely with a steady flame. Numbers 7, 8, 9 and 10 burned quite freely, but in order to ignite them it was necessary to touch the liquid with the flame, thus generating enough vapor to support combustion. It was necessary to heat No. 11 to about 110 degrees F. before it could be ignited, but it burned for some time. No. 12 was heated nearly to the boiling point before it could be ignited, after which it burned only a short time, showing that a 25% solution is about as weak as will burn at ordinary temperatures. In other words, if enough cold water be added to burning alcohol to reduce it to 25% purity, the flame will cease.

SUMMARY.

The following is a summary of the results of the experimental work as far as completed in regard to the comparative values of alcohol and gasoline in the production of light and power.

1. The higher heat value of 94% alcohol is but 68 to 71% that of gasoline.

2. The lower heat value (the value more nearly attained in practice) of 94% alcohol is but 66% to 69% that of gasoline.

3. When used for the production of light, 94% alcohol will produce from 53% to 85% as much light as an equal volume of gasoline.

4. Alcohol of 94% purity must be sold for from eleven to seventeen cents per gallon to compete with gasoline for lighting purposes at twenty cents per gallon (the present retail price of gasoline in Ames).

5. Alcohol, when used in a generator lamp, will produce from two to four times as many candle power hours as kerosene in a wick lamp.

6. It was found impossible to soot the mantels of any of the lamps with alcohol.

7. Alcohol of 94% purity, when used in engines designed for gasoline, has but 68% to 85% the value of gasoline in the production of power.

8. To compete with gasoline at twenty cents per gallon for use in gasoline engines, 94% alcohol must be sold for from thirteen to seventeen cents per gallon and 90% alcohol from eleven to fifteen cents per gallon.

9. None of the engines could be started readily with alcohol, although a few could be started with less difficulty than others.

10. After having once been started with gasoline and warmed up, the carburetors as designed for gasoline vaporized the alcohol successfully, except in one instance.

11. No doubt the gasoline carburetor can be readily changed to permit the use of alcohol as well as gasoline in the same engine.

12. Experimental work does not include tests of the special designed alcohol engine which should show better economy in the use of alcohol.

13. Gasoline cannot be used readily in a special designed alcohol engine using high compression on account of pre-ignition.

14. The odor of the exhaust of an engine when using alcohol is not as unpleasant as when using gasoline.

15. Alcohol is much more pleasant to handle.

16. There is much less danger from fire when using alcohol than when using gasoline owing to the fact that alcohol does not vaporize as readily as gasoline and its flame may be extinguished with water.

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FUTURE FORESTRY IN IOWA

Bulletin 4

Department of Forestry

(Reprint from Ames Forester, Vol. 3, 1915)

IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS

SCIENCE WITH PRACTICE

IOWA STATE COLLEGE
Ames, Iowa

Future Forestry in Iowa

G. B. MacDONALD
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Unlike most of the states, Iowa has a relatively small area of non-agricultural land, in fact, about ninety per cent of the State is adapted to the production of annual crops. For this reason, if for no other, state or national forests will not be of large extent. The areas which might best be used for timber production are in relatively small units and far separated, making their administration under national or state supervision more difficult than in those states where considerable areas in one locality are suitable only for tree growth.

The fact that Iowa is more highly favored than her sister states in having the highest percentage of soils of agricultural value, should tend to stimulate better forestry on her timber areas rather than to create a spirit of indfference toward them. In some localities of the State we are led to believe that the very prosperity of the land holder has created an attitude of indifference toward the less productive areas. Numerous examples may be found where the lands which are turned with the plow are handled in such a manner as to squeeze the last cent from the soil, while adjoining areas, suitable for timber production only, and capable of producing substantial returns, are entirely disregarded. In brief, many land owners are carrying at a loss areas which might be made productive if given a little attention.

Iowa's forestry problems are quite different from those of the mountainous states. It is probable that provision may be made in the future for both state and county forests of relatively small area, but these features, although of great value, are not of the first importance. The State is concerned more in the connection which forestry has to the individual land owner. Every farmer in Iowa should be concerned in the windbreak, shelterbelt, or woodlot.

There is another phase of forestry which has as its purpose the better utilization of forest products which involves the using

of cheaper or inferior woods for various purposes after treatment with preservatives. Good forestry may be practiced just as effectively through conservative use as through scientific production of forest products.

MEASURES STIMULATING FORESTRY

Iowa has probably taken advantage of the legislative acts encouraging tree planting as much as any other state. It is estimated that the State now has about 210,100 acres in planted timber, a large portion of which was set out in the early days. The early plantings consisted mostly in the short-lived trees—willow, cottonwood and soft maple. These woodlots have given good returns not only from the wood produced but by the protection afforded the home buildings, orchards, annual crops and feed lots.

A later attempt to encourage timber planting came in 1907 when a tax exemption bill was passed. This act, in substance, provided for the taxation of woodlots of not less than two acres on an assessed valuation of one dollar per acre, provided the land was stocked with a certain number of trees of specified species and provided further that all live stock was excluded from the woodlot.

The State Horticultural Society has been a factor in stimulating activities in forestry, especially those phases relating to the farm. Later, the Iowa Park and Forestry Association (now the Iowa Forestry and Conservation Association) in conjunction with the Horticultural Society has been a means of disseminating information regarding the planting and care of woodlots. Some work, also, has been done by the educational institutions of the State in meeting the forestry problems.

THE WINDBREAK IN IOWA

We sometimes wonder if the early settlers in Iowa planted the rows of cottonwoods, willows and maples merely because they had nothing better to do. Observations will show that these pioneers had a definite object in view—that of protecting their crops, buildings and stock against the drying winds of summer and the cold winds of winter. We find numerous instances of a later generation cutting down the windbreaks for the avowed reason that they sap or shade the soil too much and

A dense windbreak of arborvitae and Norway spruce. The area has never been pastured and the trees have not been damaged by the intrusion of live stock.

Ames forestry students setting out a commercial plantation of coniferous trees on sandy waste land adjoining the Mississippi River. The bluff lands in the distance should also be used more efficiently for the production of forest trees.

consequently decrease the producing capacity of the soil. Invariably the man who cuts down the windbreak sees only the decreased crop production in the immediate vicinity of the row of trees—and has never gone to the trouble to measure the increased production which is affected, often to a distance of forty rods to the leaward of the windbreak. His assumption that he is being injured rather than benefitted by the windbreak is generally erroneous.

Observations by the government, states and educational institutions have shown without question that windbreaks of the right tree species, when properly placed, are effective in conserving soil moisture during the growing season, by checking the velocity of the wind near the ground surface. Actual crop measurements have demonstrated that the saving in soil moisture is directly translatable into increased crop production and thus into cash.

The windbreak for crop protection is one phase of forestry in which the farmer should be most interested. With the rapid increase in land values, crop production should be greatly increased not only through better seed selection and improved methods of cultivation, but also through the efficient use of the windbreak. Instead of a decrease in the number of windbreaks in the future, Iowa's farms will show a decided increase in this protective feature, which will be in keeping with the spirit of a more conservative use of the soils of the State.

THE PLANTED WOODLOT AND SHELTERBELT

The larger part of the acreage in planted timber in Iowa is in the form of small groves varying in extent from one-half an acre to three acres. In nearly all cases the woodlot and shelterbelt are combined. The groves, almost without exception, have been placed in such a manner as to give good protection in the winter against the cold, northerly winds. In this way the farmstead has been made more habitable both for man and beast. The early shelterbelts were rightly planted to fast growing trees in most cases for the purpose of securing quick protection. Some, however, looking farther into the future either planted longer lived species or at least supplemented the short lived plantings with longer lived trees. The idea of having the shelterbelt serve also for the production of fence posts, poles, fire

wood, etc., was of secondary importance to the farmer. Some of these original groves, after thirty to forty years' growth, have been harvested and have surprised the owners in the money returns produced. The yield in lumber, fuel and posts was incidental inasmuch as the woodlot had served its purpose for protection. Cottonwood windbreaks and woodlots have given especially good returns when sawed into lumber. Numerous instances are on record of farmers building a large part of their farm buildings from timber planted by their own hands.

Another feature of the woodlot and shelterbelt which cannot justly be disregarded is its aesthetic value. The farmers of Iowa today are modernizing their homes and making them more attractive. The independent farmer of the present time will not be required to live as the pioneers did, amid none of the conveniences of modern life, but will have a home which at least approaches in convenience those of the towns and cities. If one addition more than another adds attractiveness to the prairie farmstead—it is the timber which surrounds the home grounds. The aesthetic value is not imaginary—it is a real value. A prospective purchaser of a farm generally is willing to pay an increased price for the aesthetic value afforded by the presence of a good grove of trees adjoining the home buildings.

Every farm owner in the treeless sections of Iowa should be interested in the woodlot and shelterbelt. The planting, with a little foresight, may be made to serve the several purposes of shelter, production of forst products and adding attractiveness to the farm. It will not only be a problem of planting the shelterbelt but also a question of giving the planted area good care. Most of the present planted groves in Iowa have grown in spite of the owners' negligence or lack of proper instructions. It is a mystery how many of the groves survived the trampling, browsing and breakage caused by stock. The portion of the woodlot which is to be used for protection against winds and for production of timber should not be pastured.

A problem also which confronts many farmers at the present time is that of how to rejuvinate the old shelterbelt which was made up entirely of quick-growing, short-lived species. Many farmers desire to make the shelterbelt and woodlot a permanent feature on the farm without going through the tedious process of growing an entirely new grove after the old decadent trees have

been cut. This is one of the many problems which must be worked out.

THE NATIVE WOODLOT

The agricultural interests of the State have overshadowed other interests to such an extent that we sometimes overlook the value represented in a stand of native timber. In nearly all parts of the State the original forest has given way to agriculture, yet, in many parts, especially on the rough areas adjoining the larger water courses, a remnant of the former forest remains. In northeastern, eastern and southern Iowa areas of timber of considerable extent are now to be found. These areas have been invariably culled over and in many cases the stand is mostly second growth timber. The oaks and other valuable timbers have been cut heavily for railroad ties, fence posts and lumber. In the cutting no thought has been given to the permanence of the stand or resulting species. The cutting policy in these native woodlands, which we may designate as "woodlots," has been dictated by immediate needs only. As a result, the poorer, less desirable trees, which are the last to be cut, are occupying the soil.

It is an easy matter to dictate that good trees should be left to restock the land after cutting—but how will this be done in the face of the fact that there is little or no market for the poorer species—which, as a result, are not cut? As fast as the commercial species are removed they are replaced largely by some of their undesirable neighbors. Except in restricted localities, little progress has been made in developing markets for any but a small portion of the woodlot products. In the State there is a pressing need not only to show the owner of timberland how his timber should be cut in order to secure the best silvicultural results, but also to show him how his timber, good and poor, should be handled on the market to produce a revenue consistent with the investment represented.

It is true that the owner of native woodland uses the area for other purposes—and for timber production merely because he does not go to the trouble to clear the land. In the majority of cases the timberland is pastured—a procedure which is disastrous if the stand is to be reproduced. Grazing animals injure the young trees not only by browsing the twigs and by breakage,

but also by exposing the roots and packing the soil. On very rough lands the damage to the forest by grazing is more marked—due to the greater possibility of soil erosion. Numerous instances of extreme damage are witnessed on steep slopes which have been denuded of timber and then heavily pastured. After the resulting gullying process is well under way the land is fit neither for grazing nor for timber production.

It is interesting to note that the Iowa woodlot owners have not generally taken advantage of the tax exemption act which provides for practically the elimination of taxes on woodlands which are listed with the proper officials of the State. The law sets no limit on the acreage which may be listed, provided, as before indicated, certain requirements are met. It is evident that the majority of woodlot owners prefer the grazing privilege to tax exemption even though the former is destructive from a silvicultural standpoint. No state in the Union has a more lenient system of taxing forest property—yet comparatively few timber owners are receiving the benefits offered by this act.

The greatest difficulty with the native Iowa woodlot is that it is not handled on a business basis. So long as one is in possession of forest property he is no more justified in ignoring fundamentals relating to forest management than in disregarding accepted principles in crop production on crop production on his agricultural lands. The woodlot in the State should be a source of revenue—not only from its stored-up capital or mature timber, but also by producing the maximum annual increment of the most profitable species.

COMMERCIAL TIMBERLANDS

Iowa's woodlands are now supplying the raw product for a number of manufacturing establishments which apparently are permanent in character. These establishments are crating and box board mills, excelsior mills, basket manufacturing plants, small lumber mills, and gun stock and tool handle factories. Most of these establishments are acquiring timberland of such character and extent as to insure the permanence of their industry. Some of these operations are now controlling thousands of acres of timberland. Little progress, however, has been made in the scientific management of these areas for the specific purposes desired—rather, the operators, after an indiscriminate

A cut-over stand of timber on one of the Mississippi River islands, near Harpers Ferry, Iowa. The timber was used for the production of excelsior and for box boards.

A view on one of the larger islands in the Mississippi River near Lansing, Iowa. Although some portions of these islands are too swampy for good timber production, a large percentage of the areas will support a good growth of several of the fast growing species of trees. The bluffs in the distance could be made to produce good returns from timber production if planted and given protection.

cutting of timber, are holding the land for new growth of any species of trees which nature sees fit to provide—even though these may not bring the greatest profits to the industry.

It is probable that four classes of land will eventually be utilized for the commercial production of timber for supplying specific industries. These lands are (1) Native timberland in the rougher portions of the State; (2) Exposed bluff lands or steep slopes adjoining the larger water courses; (3) Sandy stretches and poor soils; (4) Islands and lowlands in and adjoining the large rivers of the State.

It will be noted that all of the above four classes of land, as a rule, are found along the water courses.

The present native timberlands, notwithstanding the fact that the most valuable trees have been removed, will furnish a large amount of material for specialized industries. During the past years it has been too easy to bring in the raw material or manufactured products from other regions more abundantly supplied with timber, consequently there has been little inducement for development of wood manufacturing industries in Iowa. It is quite probable that the next decade will see a better utilization of Iowa's timber resources—a condition which will be brought about by the gradual decrease in production in those regions which have been exploiting their timberlands and also by the steadily increasing demand for a better utilization of all classes of land in the State.

The second class of land which may eventually be used for the commercial production of timber is the bluff lands or steeper slopes which are either wooded or bare at the present time, and which are best suited for timber production because of the unstability of the soil when used for other purposes. This class of land, in many instances, might fall under the first class mentioned. It is true, however, that long stretches of bluffs are to be found which have been entirely denuded of timber or have not been forested in modern times, due to fire or other causes. That such lands as these can be made to produce timber of high quality, after being artificially stocked, is hardly questioned. In northeastern Iowa where large areas of this character are to be found, the white pine is native and would probably thrive on such lands if given adequate protection from fire and stock after planting. The white pine in other portions of

its range probably ranks first among coniferous trees for artificial forest production, mainly because of its relative rapidity of growth and the many uses to which the lumber from this tree is put. The white pine is only one of many trees among the evergreens and hardwoods which could be used successfully on this type of land.

A third class of land which might be profitably used for commercial forest purposes is the sandy stretches and other soils of poor quality which are not suited to the production of agricultural crops. These lands in Iowa are of relatively small extent. Experimental plantings are demonstrating that numerous coniferous trees will thrive on these poor soils.

Another type of land which ranks next to the first class mentioned in possibilities for forest production, consists in those areas along the water courses of the State which are inundated at certain seasons of the year and which, for this reason, are of little value for agricultural crop production. The exact extent of lands of this kind in Iowa is not known, but it is quite certain that the acreage would total possibly hundreds of thousands of acres. This class of land would include the larger islands of a permanent character found in the large rivers bordering the State. It is known that the river bordering one county of the State has, in islands alone, fifteen to seventeen thousand acres, which are valuable only for timber production and pasture. Much of this land is now timbered with somewhat inferior species, due to the culling over of the land for the best trees. In the aggregate, the possibilities of forest production on lands of this character are enormous. The lands in their present condition are, in certain cases, producing good returns with no care and absolutely no protection against stock and fire. Iowa fortunately possesses trees of rapid growth which reach their optimum development on low land of this kind. Notable among these is the common cottonwood, a tree of extreme rapidity in growth and one which will be given more and more consideration as time goes on. Investigations in the State by the Experiment Station have shown that a production of from thirty to fifty thousand board feet per acre can be produced in cottonwood plantations on a rotation of thirty to forty years. Already industries have sprung up which are using only timber from land of this character, not only as a passing source of income but with the idea

of operating permanently, which naturally necessitates at least a crude system of management for these woodlands. An excelsion mill at Guttenberg on the Mississippi River, is utilizing cottonwood, aspen, basswood, willow and butternut for excelsior production. A crating mill on the River near the northeast corner of the State is utilizing absolutely every species available and is sawing every stick of timber, including branch wood down to a limit of three inches in diameter. Fifteen hundred acres of island lands are providing a permanent supply of timber for this mill. A large basket manufacturing company in eastern Iowa has been using, exclusively, timber from lands subject to inundation, and has made provision for a permanent supply.

In the development of commercial timber holdings there is a need for scientific management which means better management and consequently better returns. The next few years should see progress in this direction. The State should take the lead in giving assistance either directly to the companies concerned by demonstrations, technical advice, or possibly by example or experiments conducted on State lands.

STATE, COUNTY AND MUNICIPAL FORESTS

The principal forest activities of many of the states are in connection with the administration of the state and national forest lands. In Iowa, lands which might be set aside for these purposes would be difficult to administer, since the areas must necessarily be more or less widely separated. In adidtion, practically all the land within the State boundaries is privately owned and forest land could only be set aside after purchase or donation. From the standpoint of timber production only—there is little excuse for either national or state forests in Iowa. Other considerations, however, may be given emphasis which would make state forests not only possible but desirable. The value of the forest as a regulator of stream flow and as a means of preventing erosion in localities with a rough topography, is quite generally admitted. Sinve the mis-treatment of certain forest areas in the State might jeopardize the rights of others by increasing erosion, filling stream channels and in other ways, it might be desirable to have state control over the management of certain of these lands, or at least to have state supervision over the cutting of the timber.

Many of the European countries have realized more than we have the aesthetic and recreative value of the forest. If, in addition to the production of timber, the State should develop forests of her own for protecting the streams and beauty of the hills, and, in addition, for furnishing recreation for the people of the regions, then we would quite generally agree that the state forest has a place in Iowa. The state forest idea might work hand in hand with other conservation interests. Such areas might serve as game refuges for the protection of wild birds and animals and at the same time be just as valuable for timber production and possibly more so for recreation.

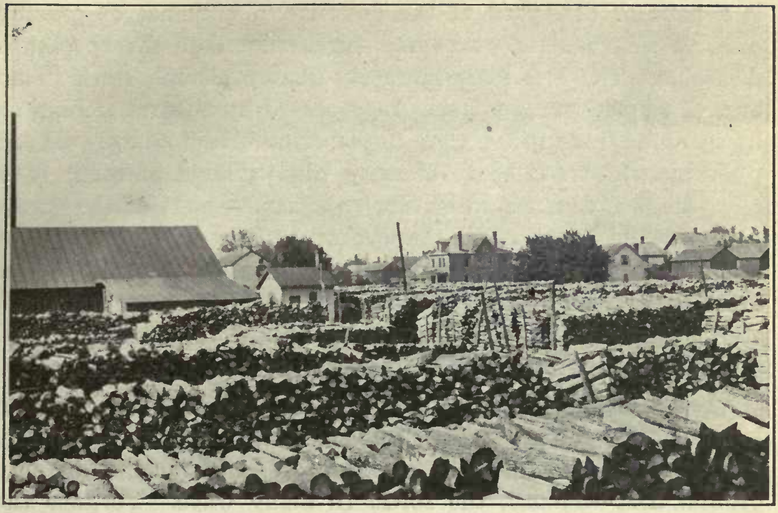
County and municipal forests might serve the people even more than such areas set aside by the State, since the forest would be close at hand and within easy reach of all. Counties which have large streams running through them generally have an abundance of woodland admirably adapted for this purpose. Towns and cities in almost any region could secure areas varying in size from one hundred to a thousand acres or more, which could be held as woodland parks. We could hardly expect such forests to produce sufficient income to do away with the local taxes as is the case in certain municipal forests in Germany, but they would serve as a source of revenue and at the same time furnish more valuable returns as a recreation ground for the people.

It is probable that there will be a considerable amount of activity in the State, relating to the establishment of municipal, county and possibly state forests. In many localities a neuceus for such might be made by donation, as has already been done in at least one country.

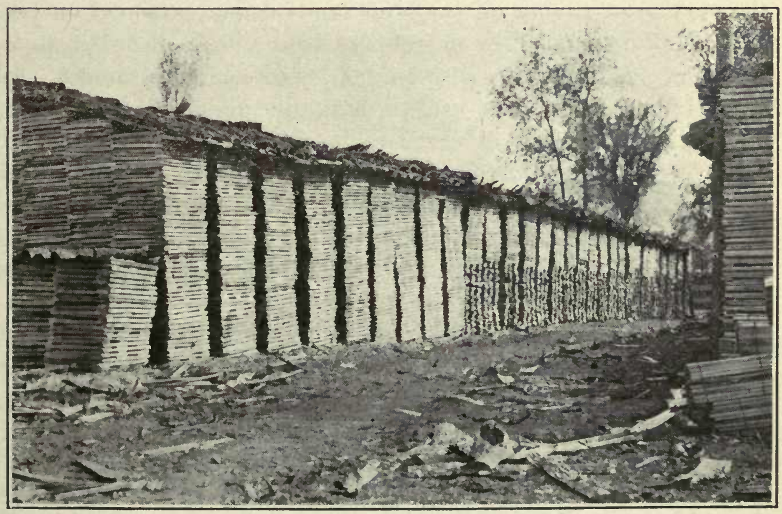
OBSTACLES TO GOOD FORESTRY IN IOWA

Although the present tax law for forest property in this State is not the most scientific, it is much better than the laws in those states which make no special provision for the forests. If the present tax law relating to the woodlots were to remain as it is today, it would mean practically an exemption from taxes for this class of property. It cannot be said that the present tax law in Iowa is standing in the way of forestry as an investment.

Probably grazing is one of the msot serious matters affecting the reproduction and proper maintenance of the woodlots. There



2,000 cords of basswood, cottonwood, aspen, willow and butternut timber in the yard of the excelsior mill located at Guttenberg, Iowa.



Crating material sawed from inferior species of timber grown on the Mississippi River islands. The mill itself is located on an island.

is a popular disregard of the destructive influence of grazing animals in woodlots where the regeneration of the species is desirable. There is little more excuse for placing stock in an area of timber which is being regenerated by natural seeding or by sprouts after cutting, than to place animals in a newly set out plantation of trees, or in a newly planted field of corn. The effect in each case would be much the same—most of the young plants would be killed or permanently injured. The owner of either planted or native woodlots should at least protect these areas entirely against stock while the young trees are getting a start. Many shelterbelts have been ruined for their purpose, by being pastured early in their formation.

The fire damage to forest property in Iowa is much less than in many other states. In few cases is the standing timber actually destroyed, but constantly recurring fires—although they be only ground fires—damage the forest in many ways. Perhaps the greatest damage comes through the complete destruction of all reproduction. In addition, the ground litter is destroyed, which not only takes away the natural fertilizer but reduces the moisture holding caapcity of the soil. It also subjects the soil to erosion and excessive damage when pastured.

Near a certain town in eastern Iowa the citizens prohibited the cutting of timber on the bluff lands which extended on two sides of the town. The object was to maintain these areas in their natural beauty, as it was a matter of common interest. As a matter of facts, fires ran through the areas annually, and, although not actually consuming the old timber, the fires left every tree badly scarred or "cat-faced" at the ground, and naturally not a vestige of reproduction remained. This illustrates one of the inconsistencies which may be met with. The people in this particular locality were much concerned about saving the wooded hills in their locality, but no one was at all concerned when fires were running through the area, which would in time ruin the forest much more completely than if every tree were to be cut down. The difficulty, as is the case with grazing, comes not so much through an intentional disregard of these matters, but because the people are not generally informed.

Another factor is working against forestry as related to the farm is tenancy. The tenant who can not look ahead even four or five years in the production of annual crops and conserve the

soil fertility, can hardly be expected to provide for shelterbelts, windbreaks or woodlots which produce their returns in protection and products largely in the future.

The man who owns his quarter or half section is the man who is interested in providing these extras which not only add to the value of the property and increase profits, but also make the farm more habitable. In the native woodland, which may not be in direct connection with the farm buildings, there would be the same tendency toward degeneration through tenancy. Either the tenant would make use of the products of the woodlot for his own ends, at the expense of the woodlot, or he would damage it by over grazing. In case the natural woodland is to thrive under tenancy it will only be under strict regulations from the owner.

WHAT IS NEEDED

Iowa's needs in forestry matters are largely educational. The State should provide for these needs either through the educational institutions, the experiment station or by a commission. In any event, funds should be made available for carrying on experimental or demonstration work which would assist the farmers and timber owners in solving their problems. This work might well be placed under the supervision of the Director of the State Experiment Station, since a number of lines of forestry experimental work have already been taken up by thisorganization and the results are being published for distribution.

The following lines of work are needed:

1. Providing for the examination of woodland tracts, after application has been made, for the purpose of proposing methods of scientific management.

2. Providing for making planting plans to assist land owners in reforestation or afforestation work.

3. Providing for suitable planting stock or trees for commercial plantations, which may be purchased at a reasonable cost. This might be accomplished in one of two ways, either by inducing the commercial nurseryman to provide for furnishing small trees in large quantities at a fair price, or by having the trees grown by the State and furnished at cost to planters who have made application in advance. A number of the states have secured good results by the latter method.

4. The dissemination of information throughout the State, relating to the value of trees for protection against winds, erosion, excessive run off, etc., also for showing the value of shelterbelts or windbreaks in protecting farm crops, orchards, stock and the home buildings.

5. The publishing of reliable data relating to the destructive influence of stock or fire, especially in young stands of timber or those in which natural reproduction is being secured.

6. Providing for the establishment of demonstration plantations of considerable extent on areas which have value for commercial forest plantations.

7. Continuing investigations of trees suitable for commercial plantings—to show most productive rotation, returns which may be expected, etc.

8. Providing for investigations relating to the better marketing of forest products from the smaller woodlots.

9. Providing for a better utilization of forest products through preservative treatment of posts, poles, railroad ties and other products, and by eliminating waste in manufacture.

10. Instituting investigations for providing better legislation relating to the control of timber areas which affect the State or communities as a whole.

Bulletin No. 126 3 February, 1912

PLANNING AND ADORNING THE FARMSTEAD

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND THE MECHANIC ARTS

HORTICULTURE AND FORESTRY SECTION

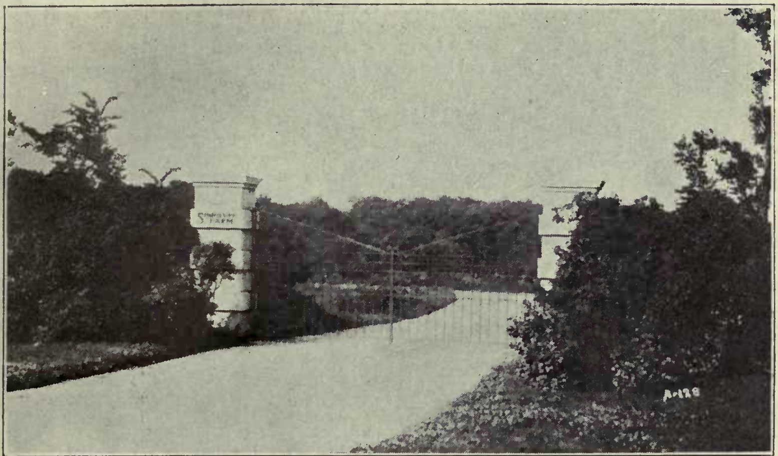
Ames, Iowa

THE COUNTRY BEAUTIFUL

"BELIEVING in the gospel of good things, I pledge myself to beautify and keep beauteous the landscape from my upper window. The four sides of my habitation shall be without offense to the sense of my neighbor or the stranger within my sight. The way before my door, my neighbor's door, or the thoroughfare of trade I will not abuse or put to unworthy use. In every way consistent with my station and citizenship, I will encourage tidiness by word and example, I will help to make the country beautiful."

PLANNING AND ADORNING THE FARMSTEAD

BY A. T. ERWIN



An Attractive Entrance Way to the Farmstead

Neat, conveniently arranged buildings, a well-kept lawn attractively bordered with trees and shrubs add greatly to the appearance and value of the farm and to the happiness of its occupants.

The farmstead, including as it does the general area occupied by the farm buildings, house and lawn, is the center of activity for the farm. Its planning and development, both from the standpoint of convenience and of securing an attractive landscape effect, deserve special consideration.

A well-thought-out plan is the first requisite to get these results, as in the absence of a definite scheme serious mistakes are likely to be made. This plan should include the location of buildings, drives, walks, trees, shrubbery, and every other feature which contributes either to the convenience or ornamentation of the place. It should be developed with the larger relationships always in mind. The location of the house and farm buildings is the first consideration. Even though it happens that some or all of these are already on the ground, a plan for their location is important. New farm homes are erected to supplant old ones and other new farm structures are added, which make practicable a general consideration of the entire building scheme. Ma-

A Good Illustration of what can be Accomplished in a Few Years.

This home was established some twenty years ago on the bare, bleak prairies of northern Iowa. With a little care and planning the surroundings have been made beautiful and attractive. There is a goodly list of varieties of trees, shrubs and vines that succeed in this section. The problem is largely one of intelligent interest and initiative on the part of the owner.

terial improvement can often be made in a farmstead by a readjustment as new buildings are put up, though the best results are obtained where things are planned right from the start.

In selecting a site for the house, good drainage is the first requisite. A south or east slope is generally to be preferred while a north slope is undesirable. In its location give the house greatest prominence. The farmstead first of all provides a home and the residence should stand out as the central and most conspicuous feature of the picture. To place the barn and other buildings in front of the house is to reverse the logical order of things. Locate the house back far enough from the highway to afford privacy and give a good stretch of lawn in front, and yet

The Barn in Front of the House—an Illogical Arrangement

not so far back as to suggest a spirit of exclusion, nor with a lawn so large that it cannot be properly cared for. Most city dooryards are too small while many of those in the country are so large that it is impracticable to give them lawn treatment.

The location and grouping of the general farm buildings is a perplexing problem and each place presents its own peculiar conditions and difficulties. The most common mistakes occur in the location of buildings as to convenience. The corn crib should be located near the particular feeding-place that will call for the bulk of its supply and the toolshed where the implements can be taken up or dropped enroute to or from the field. In this connection the importance of providing enough shed room for the tools and general equipment needs emphasis. The promiscuous

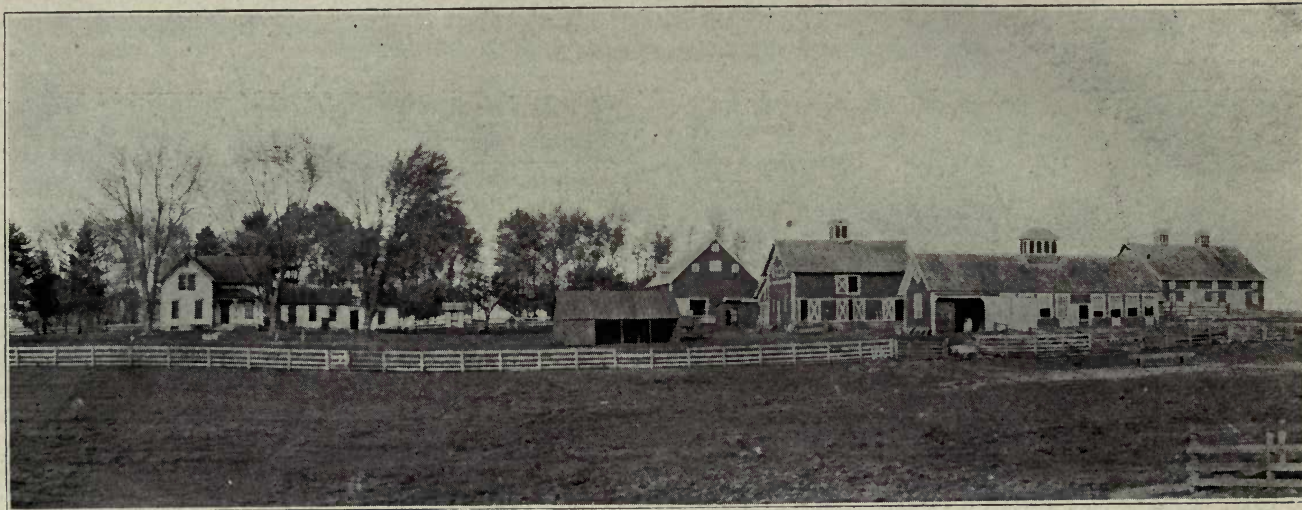
scattering of machinery about the barnyard always gives a place an air of carelessness and neglect and detracts much from its appearance, while the weathering of the machinery causes a serious economic loss. The watering-trough and workshop call for a central location.

The general farm buildings should be to the rear of the farmhouse and the stable at least 150 or 200 feet away. Locate them to avoid odors being carried to the house by the summer winds. So far as practicable, arrange the farm buildings to serve as a

"Tidiness, like everything else worth having, comes only by effort, but it is worth all it costs with a nice margin of profit."

windbreak. Locate the yards on the side farthest from the house, though it is often an advantage to provide a paddock near the highway for the display of the farm herds.

The business side of the farm must not be lost sight of and special features of the general building equipment may be given prominence, such as the seedhouse or any other important feature of the place. In landscaping the farmstead it is not the idea to obscure their presence but rather to secure an orderly arrangement of the buildings and to have the front side to the front and the back side to the rear.



A Rear View, Showing a good Equipment of Farm Buildings.

The appearance of this farmstead is much improved by the neat and tidy condition of things surrounding its buildings. Everything seems to have its place, and there is a suggestion that everything is in its place. Note the covered farm scales with their suggestion of business management on this farm.

Rural Life as it Can Be in Iowa.

This place is planted very largely to native trees and shrubs. In selecting varieties for planting it is well to give special attention to hardiness and freedom from insect and fungous troubles. Our native trees and shrubs have much to commend them in this regard. The scarlet oak, the hackberry and the hard maple are unequalled for Iowa planting. The white elm shown above is the finest of shade trees for this section.

DRIVES, WALKS AND GATEWAYS.

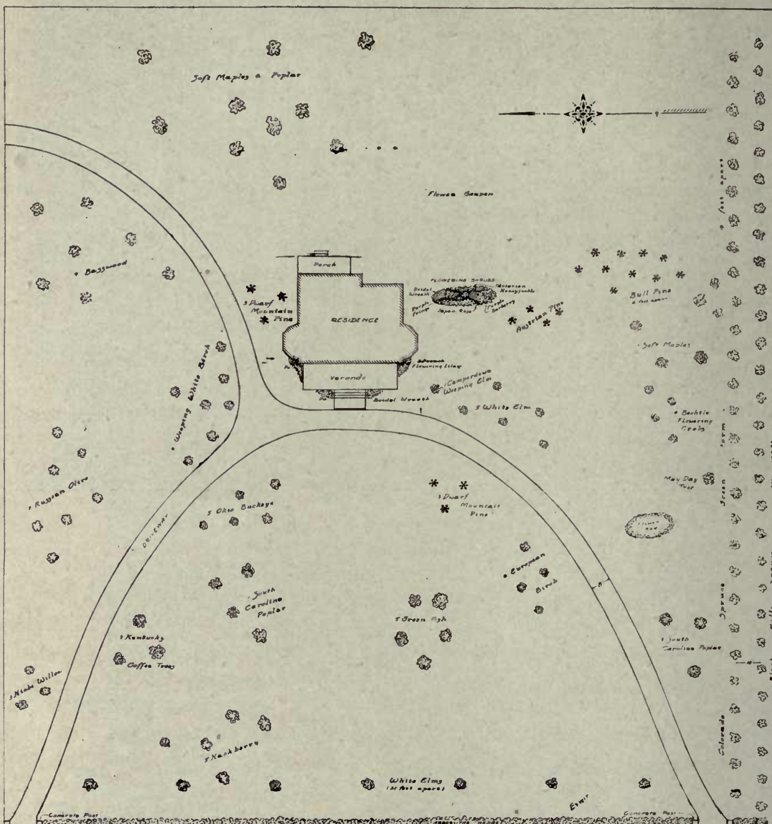
The main driveway should enter from the direction of the heaviest traffic. As suggested in the accompanying plan, it may be desirable to provide two drives, one leading directly to the barnyard for the heavy traffic and the other to serve the house, with a return loop for visitors. In locating drives, attention should be given to the matter of grades. Steep grades are objectionable and should be avoided whenever possible. It is often practicable to do this by following around the hill, thereby securing not only an easy grade but also a long, sweeping curve which will make a more attractive drive.

The Bulletin Board Serves a Useful Purpose

Massive concrete posts of a neat design may be appropriately used to mark in a formal way the entrance to the farmstead. Here also is a good location for the bulletin board, giving the name of the place, the proprietor, and other information. Every farm should have a name. It gives to the place a dignity and individuality that is otherwise lacking. Iowa now has a law permitting the registration of farm names and affording legal protection therefor. Keep all other signs off. The use of farm buildings as bill boards for the advertising of tobacco, etc., is cheapening. It not only detracts from the looks of a place but is an illogical thing to do. The owner should work up a reputation for his own goods and advertise his own products in an appropriate way.

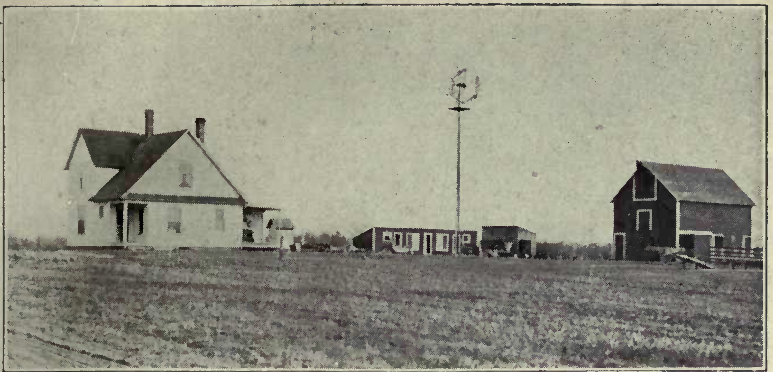
Since the majority of the country people ride rather than walk,

there is little demand for front walks, which are wholly a matter of convenience rather than beauty. When built, they should lead in the direction people desire to go. Long, circuitous routes around a semi-circle are unnatural and do not represent good planning. It has been suggested that the best way to locate a walk is to find out where people want to go by first permitting them to form a path and take that as the location. This does not mean, however, that walks must always be in straight lines. Often a gentle curve can be introduced so as not to be objectionable from the standpoint of distance and to give a pleasing landscape effect. In such instances it may be desirable to plant a tree or clump of shrubs on the inside of the curve to give an apparent reason for the deviation



Good Example of a Planting Plan.

It shows the location of every group of shrubs and every tree, their names, and number required. This drawing is on a scale of about eighty feet to the inch.

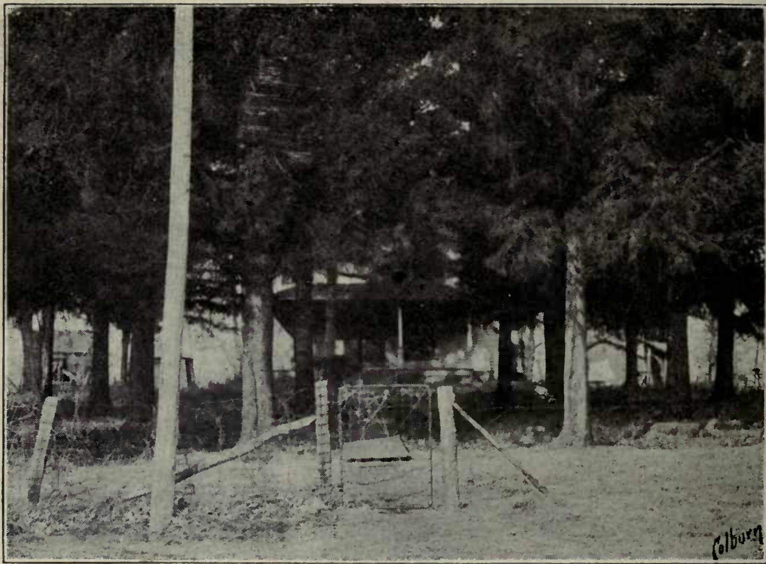


Good Buildings, but Lacking in the Shade and Adornment of Trees.

THE PLANTING OF TREES.

As one of the larger features of the landscape, the location and number of trees are of special importance. In selecting kinds the size of tree at maturity should be considered. The white elm, for example, may attain a spread of one hundred feet, while the green ash or white birch will hardly exceed one-fourth of that. Do not overplant the lawn. By filling up the front yard the landscape effect is not only destroyed but the buildings are obscured or entirely hidden. From the sanitary point of view this is also undesirable for it encourages dampness. Keep the trees back far enough to permit a free circulation of air and plenty of sunshine. Overshading is bad for a building and under these conditions the shingles decay quickly. As a protection against the afternoon sun, a shade tree or two to the southwest of the house is desirable.

In general, plant along the sides to border or frame in the picture. In this way a vista is formed with the house as the central feature. Most people err in getting things into the wrong location rather than in the selection of varieties to plant. Keep an open front. Immediately in front of the house there is nothing so appropriate as a well-kept stretch of greensward. Keep the tree planting mostly along the sides and in placing them avoid a stiff, mechanical arrangement. If an evergreen is located so many feet from the walk on one side, do not place another one at a corresponding distance on the other side. Avoid a stiff checker board plan and plant the trees more in clumps, securing the effect of a curve rather than a straight line, so that the whole will be as natural as possible. A limited number of tall trees to the rear of the house is useful for a background and the



An Over-planted Yard.

pictorial effect thus secured is a vast improvement over that of the building which stands out against a bare sky-line.

LOCATING SHRUBBERY.

One of the most common mistakes in planting shrubbery is to scatter it about over the lawn in a salt and pepper fashion. The way to secure a satisfactory effect is by grouping. Place shrubs in a mass about the border, particularly to screen off the back yard from the front, and in the corners about the porch or along the base of the building. Plant them about two and one-half feet apart, placing the taller kinds, such as the bush honey-suckle and lilac, in the back, with the lower kinds, such as the bridal wreath, in front. The shrubs should be cultivated or mulched for the first year or two after planting, after which they become sufficiently established to shade the ground and take care of themselves.

If flowers are grown primarily for cut flowers, line them out in a straight row in the garden where they can be cultivated conveniently. For ornamental beds, place them in a border two and one-half or three feet in width along the front of the shrubbery. Here the shrdubbery serves as a background against which the colors stand out much better than they will in the open. Moreover, this location avoids cutting the lawn with beds which make unsightly holes during the winter.

PLANTING LIST.

The following is offered as a selected list of trees and shrubs for the Iowa planter. Only reputable and well established varieties of known hardiness are named. The list is not complete and is meant only to be suggestive. Many of our native trees and shrubs deserve special mention in this connection as they are not only hardy and comparatively free from insect and fungous pests but also have good decorative qualities, as attested by the fact that they command a ready price in the nurseries in the regions to which they are not native. It is further suggested in making up the list of shrubbery that attention be given to the matter of the succession of bloom periods. The Juneberry blossoms very early in the spring, for example, other varieties in late spring, midsummer, and so on. In this way something attractive can be had in flower throughout the open season.

SHADE TREES.

Much of the early tree planting in Iowa was of quick growing and short-lived types such as the box elder and soft maple. Future plantings should be on a more permanent basis and of a better class of trees such as the white elm and oaks.

White elm,
Hard maple,
Soft maple,
Black cherry,
Basswood,
Ohio buckeye,

Plant Shrubbery in Clumps; do not Scatter single Specimens over the Yard.

Green ash,
Red oak,
Scarlet oak,
European birch,
Hackberry,
Carolina poplar,
Niobe willow,
Golden willow,
Russian olive.

EVERGREENS.

(For full information concerning evergreens, consult Bulletin 90 of the Iowa Experiment Station.)

Douglas spruce,
Norway spruce,
European larch,
Silver fir,
Red cedar.
White spruce,
White pine,
Austrian pine,
Dwarf mountain pine,
Scotch pine,
Blue spruce,

SHRUBS.

High bush cranberry,
Snowball,
Juneberry,
Bush honey-suckle,
Siberian dogwood.
Mock Orange.
Bridal wreath,
Nine-bark,
Japanese lilac,
French lilac,

ORNAMENTAL HEDGE PLANTS.

Hawthorn,
Buckthorn,
Polish privet.
Amour barberry,
Dwarf barberry,
Common barberry,
Purple-leaf barberry,

VINES.

Clematis jackmanii,
Clematis paniculata,
Trumpet honey-suckle.
Boston ivy,
Engelman ivy,
Bitter sweet,

TRIMMING TREES.

The climate of our state is more or less severe upon tree life of all kinds. Trees are frequently injured by the splitting down of the branches due to sleet-storms and severe winds. This condition requires pruning to insure the proper healing over of the wound, otherwise decay enters in and the life of the tree may be seriously shortened. In removing injured branches, particular pains should be taken to make the cut up close to the remaining branch and parallel to it. Under these conditions the wound is nourished and gradually heals over. Healing does not take place where a stub is left and decay gradually works down into the main stem. For cuts over two inches in diameter the surface should be coated with thick white lead.

In this connection the practice of topping back large trees, such as the soft maple, should be discouraged. This can in no manner change a soft-wooded tree to a hard-wooded kind and in the majority of instances the central portion of the large stub dies back and decays, leaving only a shell of live bark around the circumference, and in a few years the tree goes to pieces and is

A good Windbreak Contributes both Comfort and Beauty.

ready for the brush-pile. It must also be remembered that the leaf system takes part in the work of digestion and that a large tree entirely defoliated in this fashion has been treated in a very severe manner.

LAWN MAKING.

The first requisite in securing a good lawn is a rich black loam. It frequently happens that in excavating for the basement the clay soil is disposed of by spreading it over the front yard, thus leaving a very unsatisfactory soil for the lawn. Where this is done the top soil should first be taken off to a depth of 5 or 6 inches and replaced after the clay has been deposited. Similarly in back-filling around the foundation, debris of all kinds is dumped in. This is apt to cause trouble later in settling and also makes a very unsatisfactory soil with which to establish either grass or shrubs.

Grade the lawn first and then thoroughly pulverize the soil for seeding. In Iowa the best time to seed is early in the spring, though in many seasons a very good stand can be secured by sowing the seed about the middle of August or just preceding the fall rains. Fall seeding, however, is more or less uncertain on account of the lack of moisture supply. In the case of fall seeding, it is advisable to mulch the lawn the first winter with strawy manure as soon as the ground is frozen hard enough to bear up a team. This should be raked off in the spring when the growth begins. The best turf is that formed by Kentucky bluegrass. The Canada bluegrass is sometimes used but this is not as good.

Sow the seed rather thickly, say at the rate of four bushels per acre. Exercise care to get an even distribution of the seed in sowing and it is often advisable to re-seed at right angles to the first sowing in order to secure this.

For the purpose of securing immediate effect the plan is often followed of mixing with the blue grass the English or Italian ryegrass. This greens up at once and makes a very good temporary turf. Since it is only temporary in character, it gradually dies out, leaving the blue-grass in possession. In using the English ryegrass the proportion commonly followed is that of three bushels of bluegrass to one bushel of ryegrass. A slight sprinkle of white clover is sometimes added as a temporary turf. Many follow the practice of sowing oats or rye with bluegrass. This in our opinion, is not advisable. Both of these plants make a coarse stubble unsuited for the lawn and they are gross feeders. Instead of being a nurse crop they rob the grass of its moisture and food supply and also shade it too much.

MOWING THE LAWN.

Begin mowing just as soon as the grass is tall enough as this cutting causes the plant to bunch and stool-out, thus securing a thicker turf. Set the lawn mower high, however; in fact, close cutting is not advisable in any case. Stop the mowing in time in the autumn to let the grass make a good top growth for winter protection.

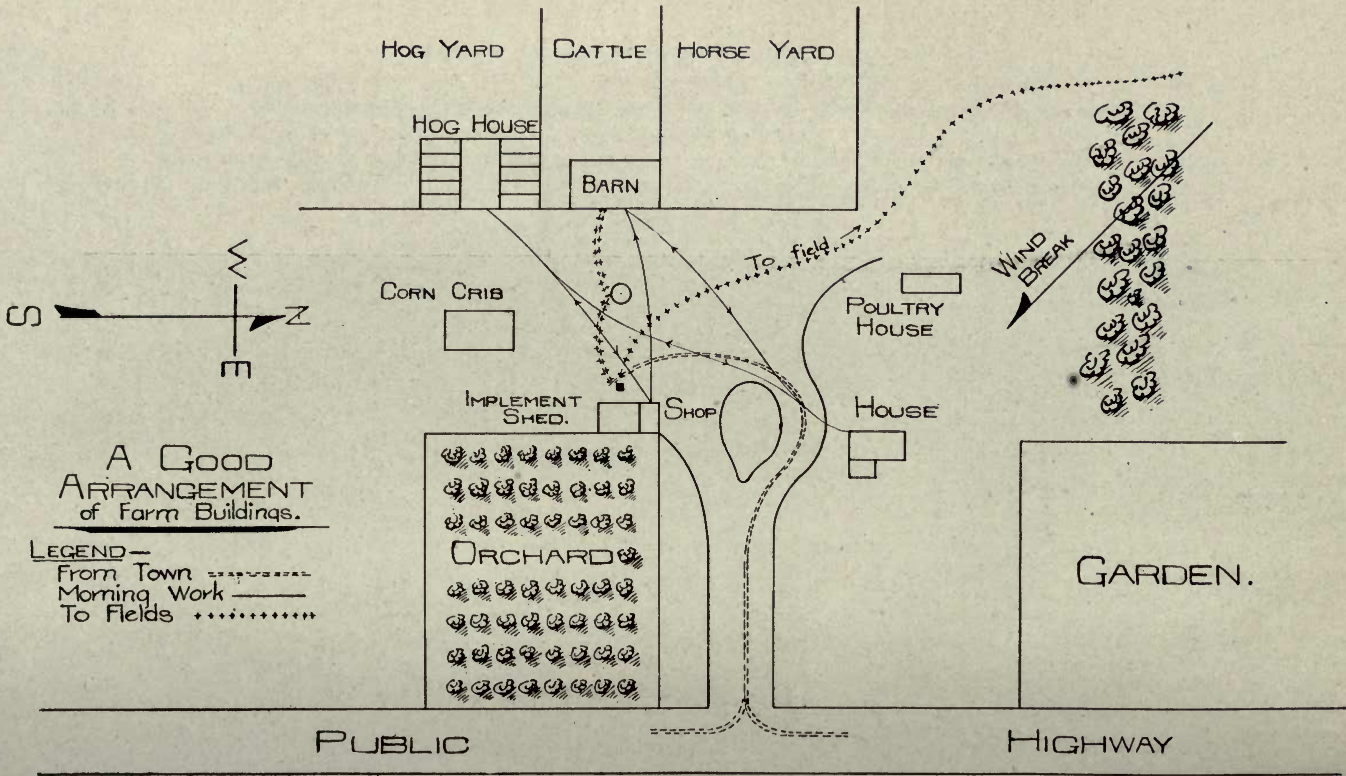
On the newly established lawn there is apt to be trouble with weeds of many kinds. Most of the coarser weeds will not stand close cutting and are killed out the first year by the use of the lawn mower. There are a few, however, including the dandelion, which are not affected in this way. For the eradication of these, iron sulfate has been recommended, but its value for this purpose seems quite doubtful.

In applying manure to the lawn take care to secure material as free as possible from weed seed. Nitrate of soda is often preferable for fertilizing because it is free from impurities. Use this at the rate of 200 pounds per acre and apply it at the beginning of the growing season.

Rolling is a good practice for the lawn as it closes the cracks early in the spring and also shoves the crowns of the plant back into place, thus correcting the heaving which has taken place during late winter.

An Attractive Farmstead.

This farmstead has many features to commend it and it gives the impression of being thoroughly practical in its arrangement. Particular attention is directed to the location of the milk house, shop and barn. Perhaps the latter is a little too far from the house. The disposition very often is to locate the barn too far from the house for sanitary reasons. If heed is given the drainage, prevailing wind direction and such things, the barns need not be so far removed. The farm garden is well located in a convenient place and where it is quite sure to receive the attention it deserves.


Hog Yard
Cattle
Horse Yard
Hog House
Barn
To field
Corn Crib
Poultry House
Wind Break
Implement Shed.
Shop
House
Orchard
Garden.
Public Highway
N
S
E
W
A Good Arrangement of Farm Buildings.
Legend—
From Town
Morning Work
To Fields

PLANNING THE FARM IN RELATION TO THE FARMSTEAD

BY J. B. DAVIDSON,

Department of Agricultural Engineering.

An investigation of the loss of time and energy upon Iowa farms on account of an inconvenient arrangement of the fields, roads and buildings indicates that farm planning should be given much greater consideration than it now receives. An inconvenient placing of the feed room, for example, in reference to the barns and house may mean only a few hundred extra feet of travel or a few extra minutes every day in caring for the live stock of the farm, but the accumulated loss for a year or number of years becomes enormous. For instance, the walking of three hundred feet twice a day amounts to over forty miles a year and in like manner fifteen extra minutes twice a day amounts to over eighteen days, of ten hours each, per year.

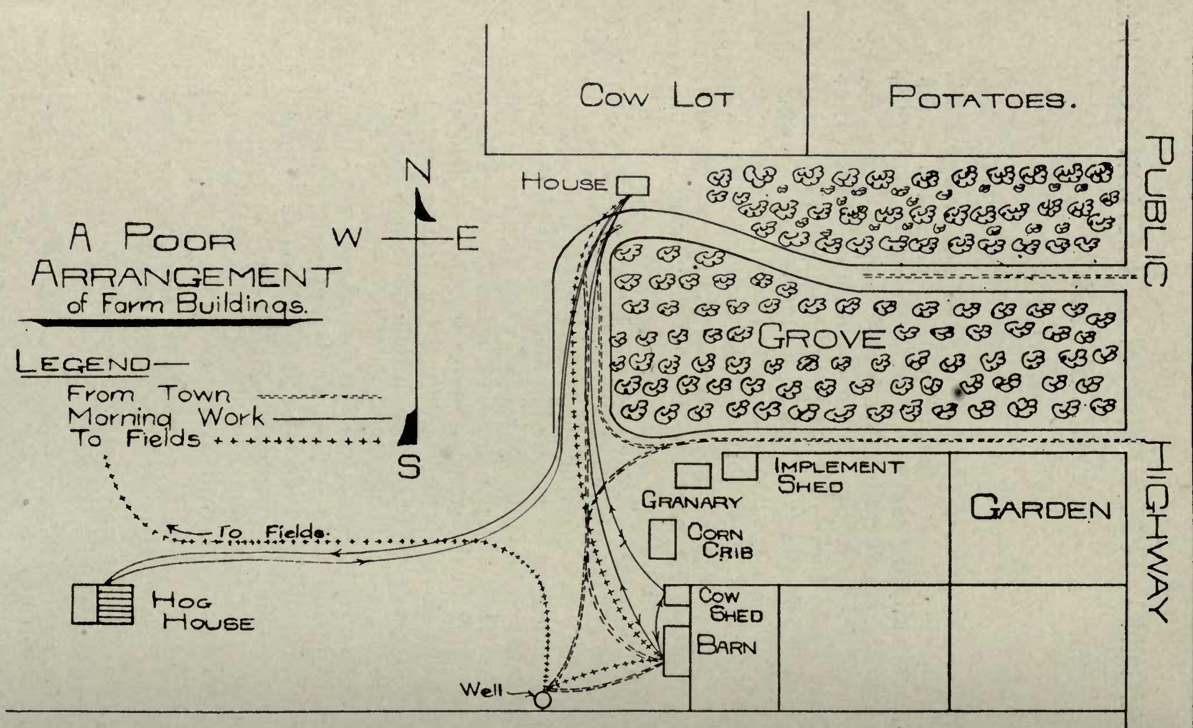
A good way to plan the arrangement of the farm, including the location of the various farm buildings, roads to the field, etc., is to prepare a sketch or map upon which the routes may be traced which must be followed in doing the day's work, including the morning and evening chores and a trip to town or other places of traffic. The accompanying sketch shows such routes and attention is called to the convenience secured. It is true that upon most farms the fields and buildings are already located, yet adjustments are made from time to time and these should be made according to well-thought-out plans in order that the general arrangement may improve rather than grow less convenient. To assist in laying out the farm and planning the farmstead, the following general considerations are suggested. Perhaps it will not be possible to incorporate all of these principles in any one plan, yet they represent advantages which should be secured if possible, though it is realized that each farm is a problem in itself.

1. Have the fields as nearly the same size as possible in order to facilitate crop rotation.

2. Have as many fields as possible in direct connection with the barn lot.

3. Size of fields should be in proportion to size of entire farm.

4. Land of the same quality should be in the same inclosure.



An actual farmstead plan which is obviously inconvenient. Note the waste ground and the excessive travel required to care for the livestock.

5. Where there are streams on the farm, arrange the fields to border on them so as not to interfere with cultivation and to be more convenient for watering stock or irrigation.

6. Avoid needless fences on account of cost and maintenance.

7. Have the buildings near the center of the farm, giving due consideration to other advantages.

8. A pasture should be adjacent to the buildings.

9. Buildings should occupy poorest ground.

10. Buildings should be located in reference to water supply.

11. Buildings should be on a slight elevation whenever possible.

12. A south or east slope is desired.

13. Soil for buildings should be dry and well drained.

14. A timber windbreak should be secured.

15. A garden plot should be near house.

16. Buildings should not be located on high hills because inaccessible from field or roads.

17. Buildings should not be placed in low valleys on account of lack of air and drainage and danger of frosts.

18. Buildings should be located on the side of the farm nearest the school, church, and town.

19. Lots should be on the farther side of barn from house and screened from the house by trees.

20. All buildings should serve as windbreaks.

21. A farm scale is useful and should be placed in a convenient place.

22. The shop and machine shed should be convenient to house, barn and fields.

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March, 1917 4 Bulletin No. 170

EVERGREEN TREES FOR IOWA

The Colorado blue spruce is one of the most beautiful trees for lawn planting and can be utilized very well for shelterbelt.

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EVERGREEN TREES FOR IOWA

BY G. B. MACDONALD

Evergreens, or coniferous trees, are of great importance in Iowa for shelterbelts and windbreaks, to say nothing of their value for ornamental planting. Altho only a few evergreens are native to Iowa, a large number have been successfully introduced into the state, including several from Europe. The most desirable of these are listed in this bulletin with brief descriptions of their characteristics, their value for various purposes and methods of planting and growing.

A shelterbelt is essential on every farm in Iowa to protect the home buildings and the feed lots. If it is not provided by natural timber, then a shelterbelt should be planted. Likewise, the windbreak, consisting of a single row of trees for the protection of farm crops from the drying winds, is of value in Iowa, particularly in the northwestern part of the state. The evergreen lends itself excellently to both uses—much better than trees which shed their leaves in winter time when shelterbelt protection is especially needed. Evergreens may also be used for the planting of waste areas of sandy, rocky or wet lands to produce posts, poles or lumber. They may also be used effectively on lands which are too steep for cultivation to protect them against erosion.

TREES FOR PLANTING.

As a rule, evergreen trees make a very slow growth during the first few years, and stock suitable for field planting is generally from three to six years old. The average planter does not care to wait this long to grow his own trees, consequently he must purchase from a commercial nurseryman. Evergreens are also much more difficult to grow than the broadleaf trees and it is generally preferable to purchase trees of the proper age, size and quality from a nurseryman of good standing who will guarantee the trees to be the species and grade specified.

Evergreen seedlings (i. e., small trees which have never been moved from the seed bed) may be purchased for considerably less money than "transplants" of the same age and variety. The additional labor involved in transplanting or replanting the young trees one or more times naturally increases the cost of producing stock of this grade. As a rule, however, transplanted evergreen trees, altho more expensive at the start, are more economical in the end, due to the fact that a greater percent of the trees live after the final planting. This is especially true when the trees are to be planted on dry or

exposed situations where conditions are not the best for growth. The transplanting operation stimulates the development of a more compact mass of roots of shorter length, thus making the trees more easily handled. Transplanted trees generally establish themselves more quickly than seedlings.

The age and size of trees most suitable for planting differs with the species, the soil and moisture conditions of the land to be planted, and also depends on the purpose of the planting. In general, small trees, (i. e., 6 to 8 inches high) should be used. Small stock is less costly, is cheaper to plant, and generally gives better results. When only a few trees are to be planted, as for ornamental purposes, it is sometimes desirable to use stock which is from 18 inches to 3 feet in height, altho trees of this size may be relatively expensive. If an evergreen windbreak, shelterbelt or woodlot of considerable extent is to be planted, it is generally preferable to use small, thrifty, transplanted trees, not only because of the smaller cost of the trees themselves, but also because they can be planted more economically.

Fig. 1.—A thrifty Norway spruce one foot in height with a good root development.

Fig. 2.—A young European larch tree showing a poor root development.

PLANTING AND CARE.

In Iowa, evergreen trees are best planted in the spring as early as the soil can be conveniently worked. Order the trees long enough in advance to make sure that they will be on hand for early planting. In all cases, set the trees out before the new growth starts, since it is much more difficult to get good results after new roots have formed and the buds are opened.

Receiving the Trees: The nurseryman shipping the trees should pack them in such a manner as to prevent the roots from drying. Generally evergreens are received in good condition if there has been no delay in transit. In case weather conditions will not permit the planting of the stock immediately on being received, protect the trees carefully from drying out. Take trees from the shipping package and "heel" them by burying the roots in cool, moist earth. Protect the trees from the sun and drying wind by spreading a mulch of straw or leaves over the bed, or by placing them in the shade of some building. "Heeling in" prevents the trees from drying out and also by keeping them in a cool place, prevents them from starting growth.

Preparing the Ground: Many failures in planting evergreen trees result from a poor preparation of the soil. For best results, plow the soil deeply and thoroly harrow it before planting is attempted. As a class, the evergreen trees will endure soils of poor quality and when once established need little care. Some attention at the outset will often be the means of securing a good stand of trees in the windbreak or shelterbelt.

Keep the Roots Moist: The first essential in planting evergreen trees is to prevent the roots from drying. When time will permit, it is quite desirable to select a cloudy day when there is little or no wind. It should be borne in mind that evergreens must be handled with much more care than broadleaf trees in planting. It is often possible to expose the roots of some of the hardy broadleaf trees for several days without serious injury. On the other hand, only a few minutes' exposure of the roots of evergreen trees to the sun and wind will often prevent their starting growth. At the time of planting, carry the trees, a few at a time, in a bucket or other vessel, where the roots can be well protected with wet moss, leaves or earth, until the tree is actually placed in the hole for planting.

Trimming the Roots: Before planting the trees, carefully cut off the long, straggling roots and those which have been injured, using pruning shears or a sharp knife. As a rule, stock of relatively small size which has been once or twice

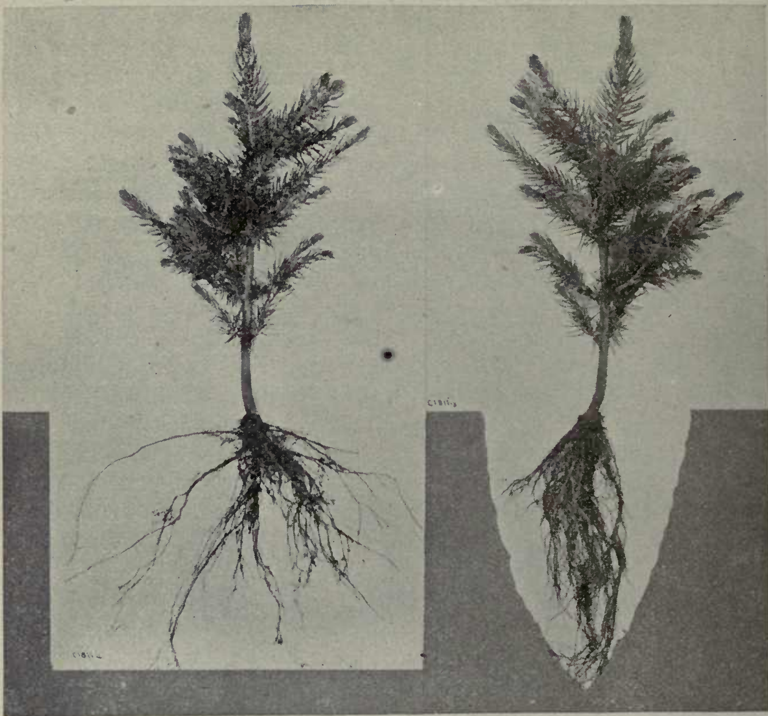

Fig. 3.—In planting, the hole should be made large enough to permit the spreading of the roots as shown at the left. A narrow, pointed hole, as shown at the right does not permit the spreading of the roots, and lessens the chances for successful planting.

transplanted is in good condition for planting. It sometimes happens, however, in planting seedling stock that the roots are very irregular, some long and some short. In such a case the long roots should be trimmed back.

Setting the Tree: If the soil has been thoroly prepared beforehand by plowing and harrowing, the planting operation will be much simplified. Make the hole for the tree amply large. For a tree 18 inches in height the hole should be from 15 to 18 inches in diameter. The bottom should be as flat as possible and not funnel shaped. This will enable the spreading of the roots, which permits the tree to draw moisture and food from a relatively large area of the soil and, consequently, makes its chances better for quickly establishing itself. After spreading the roots out carefully, add fine black soil, a little at a time, and work it in carefully but firmly about the roots. When it is planted, the tree should stand at about the same depth as it stood in the nursery, or but very little deeper. If the hole is too deep it should be filled in to the proper depth

before the planting. Pack the soil well about the tree roots as the hole is filled but take care not to break or tear the roots. The surface of the soil about the tree should be left loose to prevent excessive evaporation of moisture from the soil, or better still, add a mulching of old leaves or straw for the same purpose. The placing of manure about the tree roots at the time of planting is likely to result in serious damage and is not recommended.

The tops of small evergreen trees should not be cut back or pruned unless to remove dead or injured branches.

Cultivation: Altho the hardy evergreens will often survive if not given any cultivation after planting, their growth will be retarded by the presence of sod, weeds and brush. In the case of the slow-growing evergreens which will not stand shading, the young trees may actually be killed by the overtopping of grass and weeds. In all cases, therefore, give the evergreen plantation frequent cultivation and continue until the trees are well established or until the branches interfere

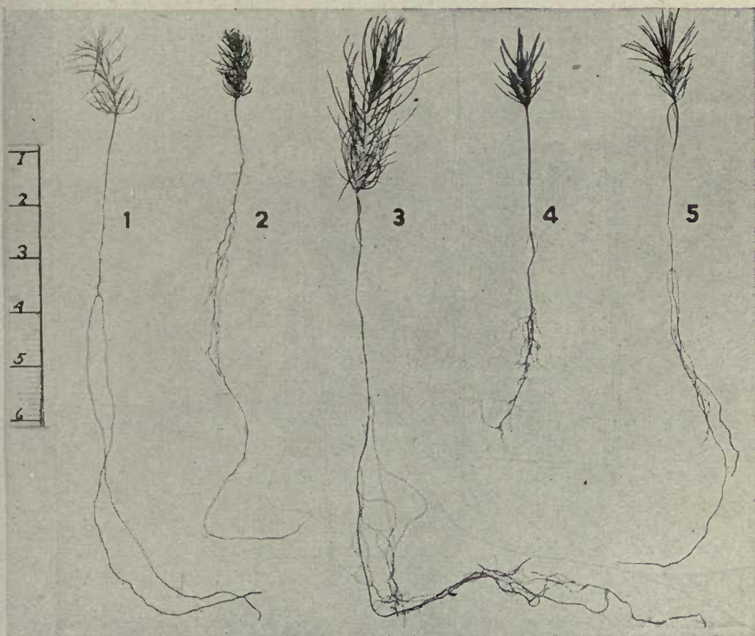

Fig. 4.—1. Showing the root development of a Douglas fir seedling after one season's growth.
2. Showing the root development of a blue spruce seedling after finishing the first growing season.
3. A yellow pine seedling after the first season. The roots of this tree sometimes are 15 to 18 inches long after one season's growth.
4. White fir seedling after the first growing season. The firs and spruces tend to send out more lateral rootlets than the pines.
5. A jack pine seedling after one summer's growth.

with the cultivation. Trees will respond to good cultivation the same as corn or garden crops and this point should not be overlooked.

Protection Against Live Stock: It is practically impossible to secure a good shelterbelt or woodlot unless all livestock are shut out from the planted area, at least until the trees are large enough to prevent serious breakage. Even then the trees may be injured, not only by the rubbing of the animals, but by their tramping and packing the soil about the roots. In a windbreak or shelterbelt it is generally desirable to have good protection against the wind close to the ground. Livestock invariably damage the lower branches of the trees and thus make them less effective for shelter. Pasturing a newly planted evergreen shelterbelt should not be practiced under any conditions.

VARIETIES FOR IOWA PLANTING

WHITE PINE—(*Pinus Strobus*)

The Tree: The white pine is not only one of the most beautiful of the pines but is also one of the fastest growers. It is native to the northeastern part of the country, the Lake States, and extends as far west as Hardin county, Iowa. For planting its range has been very much extended. It will thrive on well-drained soil of almost any quality, but best on a light,

Fig. 5.—A ten-year-old shelterbelt of white pine. Some of the trees are 12 to 15 feet in height. This is one of the most desirable trees for shelterbelt planting.

deep sandy soil with a porous subsoil. It will endure dry situations and also very moist soils if not contiuously wet. Open grown trees are generally very symmetrical in form. The fine foliage has a soft appearance when contrasted with other pines. Young trees will withstand shading for a few years but will not make a good growth in such situations. Trees planted under the shade of broadleaf trees in central Iowa, after seven years' growth, average about 18 inches in height while those planted under identical conditions, except that they were given full light, average about 7 feet in height.

The Wood: The wood is light in weight, soft, straight grained, only moderately strong, and will not warp badly. It is used very extensively for lumber, cabinet making, construction work, etc. The wood using industries of the state consume more white pine wood than any other one species.

Planting: For windbreaks and shelterbelts space white pine trees 8 to 10 feet apart in the rows, and the rows 10 to 12 feet apart. Use transplanted stock 6 to 18 inches high.

For woodlot planting space about 8 by 8 feet apart. For extensive work, use trees not to exceed 6 or 8 inches high. Plantations at 40 to 60 years of age in Iowa will produce 20,000 to 50,000 feet of lumber and yield good money returns. Commercial planting should be restricted to sandy or gravelly areas, steep slopes and isolated patches of land where agricultural crops can not be profitably grown.

For lawn or street planting the trees may be placed singly, or if the yard is sufficiently large, they may be grouped to present a larger and denser mass of foliage. For ornamental planting, it is generally not advisable to attempt to plant trees larger than 3 or 4 feet high, unless the planter is willing to go to an excessive expense.

For general planting in Iowa, the white pine is probably as valuable as any of the evergreen species and will be used extensively in the future.*

RED PINE (NORWAY PINE)—(*Pinus resinosa*)

The Tree: The native range of the red pine is much the same as the white pine, altho it is not native to Iowa. Young trees grown in Iowa are very symmetrical in form, more stocky than the white pine and the foliage has a coarse appearance, due to the relatively large needles. The old bark is reddish brown in color. In its native range the trees often attain a diameter of 3 feet. In central Iowa, on good soil, the red pine equals the growth of white pine during at least the first ten years and probably for the first 15 to 20 years. The red pine will withstand a poor sandy soil, in fact, a poorer one than the

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*Extreme care should be exercised to secure white pine stock only from nurseries or regions which are free from white pine blister rust. This rust is doing great damage to the white pine trees of eastern United States.

Fig. 6.—A thrifty young windbreak composed of red pine trees ten years old. The trees average about 10 feet in height. The red pine is one of the most desirable evergreen trees for plantng in the state.

white pine. Altho it does best on a moist, porous soil, it will make a very satisfactory growth on relatively dry situations. The tree is more intolerant of shade than the white pine, and, consequently, should not be planted under the shade of other trees or along with other species which grow faster and may overtop it.

The Wood: The wood of the red pine is light, close grained, relatively hard and of a pale reddish color. It is of less technical value than the white pine, principally because of its dark color and greater hardness. It is used in general construction work, for box boards, lumber, piling and for numerous other purposes. In Iowa the consumption of this wood is much less than for the white pine.

Planting: The red pine has not been extensively planted in Iowa, but its worth should make it a desirable tree for many localities.

For windbreak and shelterbelt planting the tree equals in desirability the white pine except for the prejudice of some people against the coarse appearance of its foliage. Space the trees 8 to 10 feet in the rows and the rows 10 to 14 feet. One of the spruces (Norway or Black Hills) would make a good associate for the red pine if planted in alternate rows. The spruce being slower in growth and capable of withstand-

ing shade, would serve to reinforce the somewhat open foliage of the red pine windbreak.

For commercial planting the red pine probably ranks next to the white pine among the evergreens for lumber production. Plantations should be restricted to poor, sandy soils or such areas as are unprofitable for agricultural crops. The spacing should be not greater than 8 by 8 feet in order to shade off the lower branches as the trees mature.

The red pine has a place for ornamental planting in Iowa the same as the white pine. The coarseness of the foliage often makes a contrast which is highly desirable for ornamental purposes.

JACK PINE—(*Pinus divaricata*)

The Tree: The jack pine grows natively from Maine to Minnesota in the United States, but not in Iowa. In the forest the tree is not considered of much value, due to the fact that it is generally closely associated with the more valuable trees, white and red pines. Altho usually of small size as compared with other evergreen trees, this pine reaches a diameter of 3 ft and a height of 80 to 90 feet in good situations. Altho very branchy and scrubby when grown in an open stand on poor soil, it is almost as straight bodied and free of side branches as the red pine when grown in even aged stands in the lake

Fig. 7.—A ten-year old windbreak of jack pine trees. Many of the trees are 15 feet in height.

states. The bark is dark reddish-brown and has a scaly appearance. The crown of the tree is very open and the foliage thin. The leaves or needles are generally less than 2 inches in length and have a light or yellowish green appearance. This pine will endure the poorest, sandy soil; in fact, it has been planted with success in almost pure sand and where the conditions during the growing season are dry and trying. Like other trees, however, its best development is obtained on a good, sandy loam soil. It is a short-lived tree, a rapid grower and a prolific seeder. In its native range it is one of the first trees to come in after the forest has been destroyed by fire. In central Iowa, on good soil, the jack pine makes a somewhat greater height growth than either the white or red pines during the first 10 or 12 years.

The Wood: The wood is weak, light, fairly hard and rather coarse grained. The lumber is generally knotty. The wood is not durable in contact with the soil. It is not used extensively for lumber except where more desirable woods are not available. The small trees make very satisfactory box boards and they may be used for fence posts if given a treatment of creosote.

Planting: The jack pine is not recommended for general planting in Iowa, due to other more desirable species being available. Its persistence on poor, sandy soils and its rapidity of growth make it desirable for use in restricted localities.

For windbreak planting space the trees about 10 by 12 feet apart. For commercial planting give them close spacing of about 6 by 6 feet in order to have the trees shade off the side branches early in their growth. Because of the hardiness of this species, it is often possible to use seedling trees 8 to 12 inches in height, which can be grown in three years.

The jack pine has little value for ornamental planting, due to its thin foliage and somewhat scrubby appearance.

WESTERN YELLOW PINE (BULL PINE)—(*Pinus ponderosa*)

The Tree: The western yellow pine is a native of the western part of the United States. The range of one form of this pine extends as far east as South Dakota and Nebraska. The resistance of the tree to adverse climatic conditions has been largely responsible for the extension of its range by planting. It is found under a great variety of soil, moisture and climatic conditions. It makes a splendid lumber tree in the west coast mountains where there is an abundance of moisture and it is the only one of commercial importance in large areas of the dry southwest and the eastern foothills of the rocky mountains.

The mature trees are large, sometimes reaching a diameter of 7 or more feet and a height of 200 feet. The bark on old trees has a distinctive yellow color and a plated appearance,

Fig. 8.—A windbreak composed of western yellow pine (left) and Black Hills spruce (right.) The trees are all about ten years old. Note the relatively slow growth of the spruce.

while that on young ones has a more blackish color. The trees are very intolerant of shade, except when young. The crowns are quite dense in youth but become more open as the trees increase in size. The foliage is coarse in appearance and somewhat resembles that of the red pine. The needles are sometimes 8 inches in length.

This pine has been planted extensively in the western part of the country. The seedlings develop a long tap root and nursery stock, unless transplanted, is very difficult to handle successfully. The initial growth of this pine in central Iowa is considerably slower than the red pine but, without question, it will resist drier situations than the latter after being successfully planted.

The Wood: The wood is strong, rather light and is not durable, except after treatment with a preservative. The timber is one of those most extensively used for lumber.

Planting: The western yellow pine is very serviceable for windbreak and shelterbelt planting in Iowa. For this purpose the trees should be spaced from 10 to 12 feet apart in the rows. If more than one row is planted, it is often desirable to use also a second species, such as the Norway spruce, which might make up the interior portion of the windbreak. Use only well-rooted,

transplanted stock from 8 to 12 inches in height. This variety is especially adapted to northwestern Iowa.

It is questionable if the western yellow pine should be used to any great extent for commercial planting in the state, since in most localities faster growing trees are available.

The tree is used extensively for ornamental planting. Open grown specimens are symmetrical and the coarse, long needles often give a pleasing contrast to the foliage of the broadleaf trees or other evergr.eens.

AUSTRIAN PINE—(*Pinus austriaca*)

The Tree: The Austrian pine is a native of Europe but has been widely planted in the United States with splendid results. Iowa grown trees form a straight, stocky trunk with heavy limbs, when open grown. The branches do not appear in such distinct whorls as is the case with the white pine, consequently the ornamental value is somewhat less altho the tree has a beautiful dark-green, coarse foliage very closely resembling the red pine. The growth of the tree during the first ten years in central Iowa is more rapid than that of the western yellow pine; is less rapid than that of the white, red or jack pines, and is almost equal to that of the Scotch pine. In hardiness the tree compares favorably with the yellow and Scotch pines. Many growing specimens of this species thruout the state would indicate that the Austrian pine makes a good growth for 40 years or more, altho it is generally classed as a short-lived species.

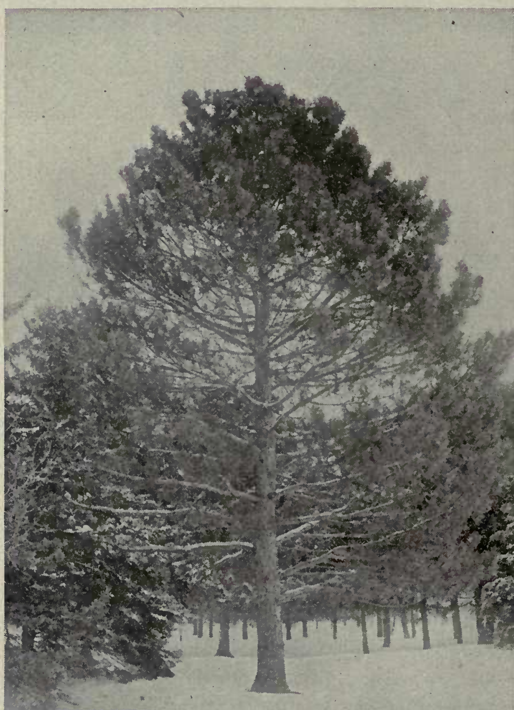


Fig. 9.—A single specimen of Austrian pine. A desirable tree for shelterbelt planting on dry situations.

The tree is a tap rooter and, as a result, is more difficult to handle in planting than those with a spreading root system. It is well adapted for planting in the drier portions of the state, although in these localities the growth is somewhat slower. It is a tree which thrives on rocky locations both in Europe and in this country.

The Wood: The wood is coarse, soft, rather brittle and of inferior value. It is not durable except after treatment with a preservative. The wood has been used very little in the United States, although if grown in sufficient amount would make a very satisfactory rough lumber which might be utilized for box boards, crating material or other purposes where great strength is not essential.

Planting: The Austrian pine has already been used to a considerable extent for windbreaks and shelterbelts in Iowa. It has invariably given good results. Like most of the pines, it is a light demanding tree and in planting with other species care should be taken not to overtop it with a faster growing species. For single or double rows the trees should be spaced 10 to 15 feet apart—close enough to interlace the branches somewhat. By spacing the rows from 12 to 15 feet apart, sufficient light will reach the trees for good growth. Seedling trees of this species have undesirable tap roots, consequently, for best results, use transplanted stock, preferably 10 to 12 inches in height.

The Austrian pine is not recommended generally for commercial plantations in the state, altho, like the western yellow pine, its peculiar qualifications make it desirable for use in restricted areas where other more desirable trees can not be successfully grown.

For ornamental planting, the growth, form of the trees and appearance of the foliage, place this species in the class with red and western yellow pine. The tree is very commonly used for lawn planting.

SCOTCH PINE—(*Pinus sylvestris*)

The Tree: Like the Austrian pine, the Scotch pine was brought from Europe for planting in this country. In Iowa it has been planted more widely than any other evergreen tree. In its native haunts, on good soil situations, it makes a fine tree of good form, but in Iowa a large majority of the trees show a crooked growth after they become 20 or 25 years old. It is commonly thot that the poor form of these trees has resulted from using seed which has been collected from the low formed trees in Europe. Altho the Scotch pine has been very serviceable in Iowa for windbreaks and shelterbelts, it is probable that a number of other evergreens would have given equally quick results and at the same time the

Fig. 10—A ten-year old windbreak of Scotch pine. Young trees of this species have a very good form but the older trees generally become crooked.

trees would be much more sightly after reaching an age of thirty to forty years. On good soil situations the Scotch pine is slightly slower in growth than either the white or red pines during the first ten or twelve years. During the same period it slightly exceeds the Austrian pine in growth. As a rule, the Scotch pine planter dislikes the tree principally because of the crooked growth it makes. In the northeastern part of Iowa, or dry exposed situations, it can be used to advantage, altho the Austrian or western yellow pines should be given preference on difficult situations.

The Wood: The wood of Scotch pine is moderately light, soft, knotty, and is not durable. In Europe the wood is used extensively. In this country it has not been used enough to be considered. Because of the crooked growth it is not desirable for lumber or posts, but might be utilized for a quick fuel.

Planting: In planting the Scotch pine for windbreaks place the trees about 10 feet apart in the rows and give them an abundance of light from the side in order to permit the development of side branches. If used for shelterbelts, the rows of Scotch pine might be supplemented with several rows of

Norway or Black Hills spruce. This would very materially increase the efficiency of the windbreak, since the spruces have denser foliage than the pine. The tree is of pracically no value for commercial plantations.

As is true with the evergreen windbreaks, the Scotch pine has been used as commonly as most any other evergreen for lawn planting. Small trees of this species make a very pleasing appearance on the lawn and many prize the older trees for their pronounced bright yellowish-red bark. The thinness of the foliage prevents the shading out of grass on the lawns.

EUROPEAN LARCH—(*Larix europea*)

The Tree: The European larch, which closely resembles the American larch or tamarack, is a native of Europe. It is one of the evergreen class which is not evergreen—that is, it sheds its leaves annually the same as the common broadleaf trees. The fact that the trees are deciduous restricts their use for windbreak purposes, since they give no more winter protection than the broadleaf trees. Unlike a number of the evergreens planted in Iowa, the European larch requires a favorable soil situation for good growth. The soil should be light, deep, moderately fertile and well drained. The trees will withstand very little shading and it is classed as one of the trees most intolerant in this regard. The larch is a fast grower. In central Iowa, plantations 35 to 40 years old average about 10 inches in diameter and 50 to 70 feet in height. The plantations are characterized by the straightness of the trees and the slight taper of the stems. Trees which once become overtopped, become badly suppressed and soon die.

The Wood: The wood of this larch is hard, strong, flexible and quite durable in contact with the soil. The tree is especially valuable for poles and fence posts. The straightness of the timber increases its value for these purposes. The wood is also serviceable for cross ties.

Planting: This tree is one of the first to bud in the spring. On this account it is important to plant the trees as soon as possible after the ground can be worked.

Altho the larch is seldom used for strictly windbreak purposes, plantings of this species are often combined in a shelterbelt and woodlot. When planted in pure stand the trees should be placed about 6 feet apart in the rows and the rows 7 to 8 feet apart. A relatively close spacing is necessary in order to shade out the grass and weeds. On good soil situations pure plantations can be grown to pole size without underplanting with a shade enduring tree. Plantations in central Iowa, when 40 years old, will produce 200 poles averaging 9 inches in diameter at the bottom and 1000 posts per acre. After 25 to 30 years it is practically impossible to keep out

Fig. 11.—A plantation of European larch in central Iowa. The trees are 40 years old and the larger ones are about 12 inches in diameter. Note the tall, straight growth and the thinness of the foliage. Plantations of this kind should be underplanted.

grass and weeds in a pure plantation of larch. An underplanting of spruce or some other tolerant species would undoubtedly benefit the stand.

For ornamental purpose the European larch makes one of the most beautiful lawn trees. Altho it does not hold its leaves over winter, the light green of the new foliage, which appears early in the spring, gives a very pleasing effect. For orna-

mental planting, use trees 3 to 4 feet high. For the woodlot, transplants 10 to 12 inches high, which are three to four years old, are of a convenient size and more economical.

NORWAY SPRUCE—(*Picea excelsa*)

The Tree: The Norway spruce is not native to North America but has been introduced from northern Europe and Asia. The tree develops a straight trunk and a pyramidal crown which becomes rounded at the top as the tree becomes old. In a dense stand the tree retains its pyramidal form but the living portion of the crown is restricted to the upper part of the trunk. The slender branches become more or less pendulous as the tree increases in age, which makes it valuable for ornamental planting. The tree reaches a good size in Iowa even on upland soil. For the higher situations where there is plenty of moisture, this spruce is much more valuable than the white or Black Hills variety, due to its more rapid and thrifty growth. This species will not endure a very dry soil but will thrive on one of moderate fertility if surface moisture is available for the shallow root system. The thee will withstand wet situations but not stagnant or swampy areas. The growth during the first 10 or 12 years is rather slow but the rate increases after that time and continues until the trees are about thirty-five years of age. The length of life when grown in Iowa under good conditions is not definitely known.

Fig. 12—The Norway is the most desirable spruce for windbreak and shelterbelt planting in Iowa. Open grown trees are very desirable for lawn planting.

The Wood: The wood is light, soft, non-resinous and moderately durable. It has been little used in this country because it has not been extensively planted for commercial purposes. In Europe it is used very commonly for lumber, paper pulp, and fuel. Because of the persistence of the side branches even in a dense stand, the lumber is generally knotty.

Planting: The Norway spruce is one of the most efficient of the trees used for windbreaks in Iowa. It has a rather dense foliage and the branches remain intact for a number of years, even in a relatively dense shade. Space the trees about 10 by 14 feet apart, when so placed, a very affective windbreak is produced in a few years. A desirable combination is to alternate rows of white cedar and Norway spruce.

For commercial planting, an 8x8 foot spacing is desirable. The presence of side branches on trees grown in an open stand, decreases the technical value of the lumber produced. Three to five year-old transplanted stock is proper for windbreak or woodlot planting. Because of the compact root system the trees are easily handled in the planting operation.

For lawns, the Norway spruce is one of the most beautiful trees available for Iowa. The drooping branchlets on trees thirty to forty years old make them very attractive.

The tree is suitable for planting in all portions of Iowa except the drier, more exposed localities in the northwestern part.

RED CEDAR (JUNIPER)—(*Juniperus virginiana*)

The Tree: The red cedar is one of the most widely distributed of the American evergreen trees. It is native to Iowa and has in the past been found in considerable quantities along the rivers in the eastern part of the state. The native timber has been cut for fence posts and few of the original trees remain. Open grown trees on good soil are spire shaped while those grown on exposed, wind swept situations are more scrubby and irregular in growth. It is one of the least exacting of the American trees in regard to soil and climate conditions. It is found on soils ranging from the best to those of poor quality in the semi-arid regions of the country. On wet soils the growth is retarded. The tree seldom attains a height greater than 50 feet in Iowa. The crown is less dense and the rapidly tapering trunk is generally more or less fluted at the base. Full sunlight is required for best development, although the trees in central Iowa make a height growth of 25 to 35 feet in 30 years. It is classed as a strong grower. In native groves the trees reproduce under the shade of broadleaf trees.

The Wood: The red cedar or juniper wood is one of the most durable of the American woods. It is light and soft with with a fine compact grain. A freshly cut piece of heartwood has a deep red color which fades on exposure. The sapwood is cream colored and is not durable. Fence posts cut from trees of this species have been used very extensively over the country and are still much in demand although the scarcity of the timber makes them expensive. Average posts will last from 30 to 35 years under Iowa conditions. The trees are also used for poles. In southeastern United States the wood has been used extensively for pencils.

Fig. 13.—The red cedar. This tree is desirable both for lawn planting and for the windbreak. It should not be planted near the apple orchard because of a fungus trouble.

Planting: The value of red cedar for planting lies in its adaptability to unfavorable soil and climatic conditions and also to the durability of the wood but not to its rapidity of growth.

This tree has been used widely for windbreaks especially in single rows and very desirable for this purpose, however because of its slowness of growth, it does not give good protection for a number of years. For single rows, space the trees 8 feet apart. It is generally desirable to plant a fast growing tree along with the red cedar, for giving quick protection, which can be removed when the cedars become effective.

The tree is seldom planted for strictly commercial purposes. A combined woodlot and shelter belt might serve as a source of fence posts. The value of the red cedar for ornamental pur-

poses is well recognized. Open grown trees in Iowa are very symmetrical. The light bluish berries add a feature of attractiveness. The trees stand pruning and trimming well but not so well as the arborvitae or white cedar.

Trees 1 foot in height or under should be used for windbreak, shelterbelt or woodlot planting. Generally trees 2 to 3 feet in height are preferable for lawn planting.

One of the greatest disadvantages of planting this tree in Iowa comes through the development of the "cedar-apple" fungus when in close proximity to apple trees. For this reason the red cedar should not be placed near the orchard.

BLACK HILLS SPRUCE (WHITE SPRUCE)—(*Picea canadensis*)

The Tree: The Black Hills spruce is a variety of the eastern white spruce which has been introduced from the Dakota region. When grown in the prairie region it is small in size, of pyramidal form, and has a well developed root system. Altho in its native habitat it is generally found on moist situations, it has been found to be very drought resistant, and, for this reason, is a valuable tree for planting, especially in northwestern Iowa. It is a tree which resists to a marked degree the drying effects of the winter winds. In planting, it is quite easy to handle because of the compactness of its root system.

The Wood: The wood is soft, fine grained, light, and not strong nor durable. The timber makes a satisfactory lumber of a poorer grade. It is desirable for box boards, crating material and for paper pulp. The trees can be utilized for fence posts after being treated with a preservative but should not be planted for this purpose alone.

Planting: In localities to which it is adapted, the Norway spruce is to be preferred for windbreak planting to the Black Hills variety. The former is not only a faster grower but also makes a larger tree. In addition, the Norway spruce is preferable for ornamental planting. On dry, exposed, wind swept areas, especially in northwestern Iowa, the Black Hills spruce is a tree of considerable importance. Because of its slowness in growth, windbreaks of this species should be reinforced, at the start at least, with a row or two of some fast growing tree such as the cottonwood. The spruce will endure the shade of the cottonwoods and after reaching a fair size the cottonwoods, or a part of them, may be removed to permit the full development of the spruce. This tree may also be planted along with the western yellow , Austrian, Scotch or jack pines. In such combinations the shade enduring spruce should make up the interior rows and the intolerant pines the outside rows.

This spruce has but little value for commercial plantations, since other hardy species are available which are much faster

Fig. 14.—Black Hills spruce trees on upland soil. These trees are between 30 and 40 years old and have a height of about 30 feet.

in growth and produce a product of equal or greater value.

For ornamental planting the Black Hills spruce is important for dry, exposed situations.

WHITE CEDAR (ARBORVITAE)—(*Thuja occidentalis*)

The Tree: In the United States the arborvitae or white cedar is native from the northeastern part of the country to central Minnesota. It is generally found in the so-called "cedar swamps" or on moist situations. Well developed trees in the open have a beautiful pyrmidal crown. The leaves are very small and are arranged in broad flat sprays. In central Iowa upland grown trees are very slow in growth and before reaching an appreciable size gradually die out. In

lowland situations where the water table is close to the surface, the trees are very satisfactory for Iowa planting. They will withstand wet soil and make a good growth if the water is not stagnant. The white cedar makes one of the most effective windbreak trees. It stands considerable shading, consequently can be grown closely spaced.

The Wood: In the United States the white cedar is used for fence posts and poles probably as much as any other tree. The native stands are dense and a large production of these products per acre is obtained. Practically all of the fence posts shipped into the State are white cedar. The tree is utilized little for other purposes.

Planting: The white cedar windbreak should only be planted on moist soil. Space trees about 8 by 12 feet apart. With this spacing the lower branches on the interior of a windbreak thirty years old are shaded off but the outside rows present a solid mass of green foliage. TheNorway spruce is sometimes planted in alternate rows with the white cedar and this combination makes a very desirable windbreak, although after twenty-five to thirty-five years the former begins to overtop the cedar. At this time the white cedar trees could profitably be taken out and made into fence posts—thus giving the remaining spruce more room for development.

Fig. 15.—A shelterbelt composed of alternate rows of white cedar and Norway spruce. This combination, if not pastured, makes one of the most effective windbreaks which can be grown in the State.

For commercial planting the white cedar could be well utilized on wet land. It should produce a crop of fence posts in 15 to 20 years but would give best returns if permitted to grow for 30 to 40 years, since the initial growth is slow. In planting use trees 8 to 12 inches high.

This cedar is very much prized for ornamental planting on lawns. It trims back readily and is used much for low hedges, although foreign varieties are more adaptable for this purpose but are not as hardy. For lawn planting, trees up to 3 feet in height can be satisfactorily planted if given good care.

HEMLOCK—(*Tsuga canadensis*)

The eastern hemlock is a native to northeastern United States and extends as far west as the Lake States. It is a very desirable tree for ornamental planting, due to its symmetry and to the graceful, drooping, soft foliage. It is suitable for planting on moist situations but is difficult to establish on upland soil where it is exposed to the summer winds.

The tree has little value for commercial plantations, becaus of the inferior quality of the wood. It is occasionally used for windbreak planting.

DOUGLAS FIR—(*Pseudotsuga taxifolia*)

The Douglas fir is native to the Rocky Mountain region and western United States. Individual trees in Iowa appear

Fig. 16.—A young windbreak of Austrian pine (left), Douglas fir (center) and red pine (right). All the trees are about ten years old. Note the relatively slow growth of the Douglas fir.

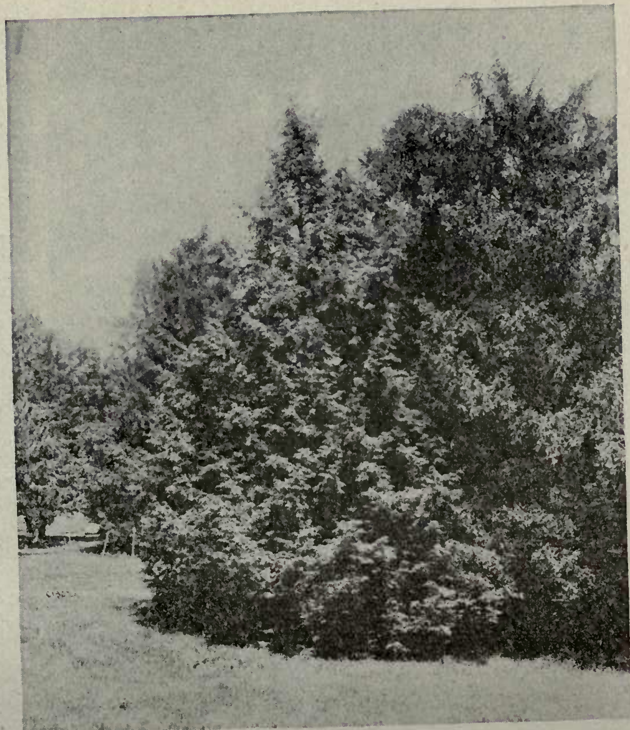


Fig. 17.—Eastern hemlock (left) and Norway spruce (right). Aside from lawn planting, the hemlock might be used effectively in a windbreak where there is plenty of soil moisture.

Fig. 18.—A clump of white pines about 25 years old. The rapidity of growth, hardiness, and beautiful appearance of this tree make it one of the most desirable for planting.

to be quite hardy. The new leaves, especially on young trees, are frequently killed by late spring frosts. On this account young trees are often of undesirable shape and poor in appearance. The tree has value for ornamental planting and possibly for windbreaks but is not recommended for general planting except in moist, protected situations.

AMERICAN LARCH (TAMARACK)—(*Larix americana*)

The American larch or tamarack is a northern species. It is generally found on wet situations within its native range. In Iowa, occasional specimens are found planted on upland soil. The tree closely resembles the European species which is much more commonly planted. For ornamental purposes it ranks with the European variety except that it is not so rapid in growth. The tree might be utilized for planting for commercial purposes on wet soils, but the white cedar is more valuable for such areas.

COLORADO BLUE SPRUCE—(*Picea parryana.*)

In Iowa this spruce is planted for ornamental purposes but has value for shelterbelt planting as well. Desirable trees have almost a perfect conical form and the foliage varies from green to a distinct bluish white color. They are very much prized for decorative purposes. The tree is hardy in all parts of the State.

WHITE FIR (SILVER FIR)—(*Abies concolor*)

Like the blue spruce, the silver fir is planted only for decorative purposes in Iowa. The trees are very symmetrical and the foliage has a silvery white appearance which makes it highly prized for lawn planting. The tree is considerably less hardy than the blue spruce and should not be planted in exposed, dry situations.

White Pine. Leaves from 3 to 5" long in bundles of 5. Cones are from 5 to 11" long.

Jack Pine. Leaves in pairs, ¾ to 1½" long. Cones woody, 1½ to 2" long, with compressed scales.

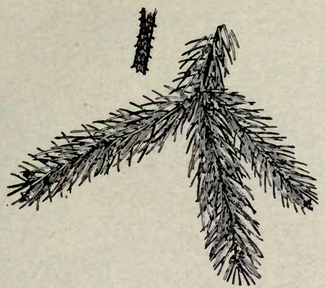
Western Yellow Pine. Leaves in clusters of 2 or 3', and 5 to 11" long. Cones woody, oval in shape, 3 to 6" long.

Austrian Pine. Leaves in pairs, 3½ to 5" long. Cones woody, 2 to 3" long.

Scotch Pine. Leaves in pairs, 2 to 3½" long. Cones woody, 1½ to 2½" long.

European Larch. Leaves in tufts ¾ to 1½" long, dropped in autumn. Cones ¾ to 1½" long.

PLATE I—Leaves and fruit of evergreens.

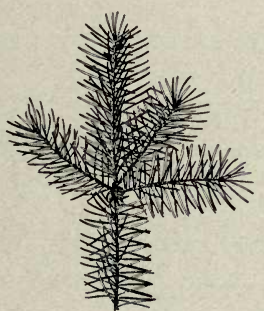


Norway Spruce. Leaves angular, sharp pointed. Cones 4 to 7″ long.

White Cedar. Leaves scale like or sometimes nearly ¼″ long. Cones ⅓ to ½″ long, composed of only a few scales.

Red Cedar. Leaves scale like, on young trees, ½ to ¾″ long. Fruit berry-like, ¼ to ⅓″ in diameter, dark blue to bluish-white color.

Eastern Hemlock. Leaves ⅓ to ⅔″ long, oblong, rounded tip. Cones ½ to ¾″ long.



Douglas Fir. Leaves ¾ to 1¼″ long. Cones semi-woody 2 to 4½″ long, with bracts protruding from between the scales.

American Larch. Leaves in tufts about 1″ long. Cones ½ to ¾″ long with about 20 scales.

PLATE II—Leaves and fruit of evergreens.

EVERGREEN TREES FOR VARIOUS PURPOSES IN IOWA

FOR WINDBREAKS AND SHELTERBELTS.

White pine
Red pine
Jack pine
Western yellow pine
Austrian pine
Scotch pine
European larch
Norway spruce
Red cedar
Black Hills spruce
White cedar

FOR DRY SITUATIONS.

Austrian pine
Black Hills spruce
Western yellow pine
Jack pine
Scotch pine
Red cedar

FOR MEDIUM TO FAIRLY MOIST SITUATIONS.

White pine
Red pine
Norway spruce
Austrian pine
Western yellow pine
European larch
Black Hills spruce
Red cedar
White cedar
Scotch pine
Hemlock
Douglas fir
Colorado blue spruce
White fir

FOR WET SITUATIONS .

White cedar
American larch
Black Hills spruce (to a less degree)

FOR SOILS OF POOR QUALITY (Sandy, gravelly, rocky, etc.)

White pine
Red pine
Western yellow pine
Austrian pine
Red cedar
Jack pine
Scotch pine

FOR SOILS OF GOOD QUALITY.

White pine
Red pine
European larch
Austrian pine
Norway spruce
Western yellow pine
Scotch pine
Black Hills spruce
Red cedar
Jack pine
White cedar
Hemlock
Douglas fir
Colorado blue spruce
White fir
American larch

WINDBREAKS AND SHELTERBELTS.

White pine
Norway spruce
Red pine
White cedar
Black Hills spruce
Austrian pine
Hemlock
European larch
Western yellow pine
Red cedar
Scotch pine

FOR THE PRODUCTION OF LUMBER.

White pine
Red pine
Norway spruce
Austrian pine
Austrian pine
Western yellow pine

FOR THE PRODUCTION OF FENCE POSTS.

White cedar
European larch
Red cedar
White pine (if treated)
Other pines (if treated)

FOR THE PRODUCTION OF POLES.

European larch
White cedar
Red cedar
White pine
Norway spruce

FOR PLANTING IN SHADE.

Hemlock
Norway spruce
White spruce
Colorado blue spruce
White cedar
Red cedar

TREES REQUIRING FULL SUNLIGHT.

European larch
American larch
Western yellow pine
Red pine
Jack pine
Scotch pine
White pine (stands some shade when young)

FOR LAWN PLANTING.

Colorado blue spruce
White pine
Norway spruce
Hemlock
White fir
European larch
White cedar
American larch
Red cedar
Black Hills spruce
Douglas fir
Red pine
Austrian pine

December, 1916 Circular No. 33

5

THE WHITE-MARKED TUSSOCK-MOTH

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

Entomology Section

Ames, Iowa

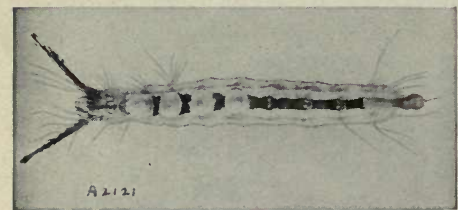
THE WHITE-MARKED TUSSOCK-MOTH[1]

By R. L. Webster

Numerous reports of the abundance of the white-marked tussock-moth in Iowa have been received this fall (1916) at the Agricultural Experiment Station at Ames. The insect seems to be common generally in the state, since reports have come in from so many widely separated communities, including Dubuque, Marshalltown, Des Moines, Fort Dodge, Red Oak, and elsewhere. While this is not a new insect in Iowa, it seldom causes such widespread notice.

THE INJURY

The injury is caused by the caterpillars of the moth, which feed on various shade and orchard trees. The insect is a well known pest of shade trees, frequently causing much damage in states east of the Mississippi river. Where abundant, the caterpillars (larvae) may strip trees completely of foliage, causing severe damage. With this in mind, it is essential that immediate measures be taken whenever the insect appears in Iowa, to prevent further damage in 1917.



Larva of White-marked Tussock-Moth

THE INSECT

The mature larva is a beautiful caterpillar, about 1½ inches long, with conspicuous tufts of fine hair. Projecting forward and diverging are two tufts of black hair, one-third as long as the body; to the rear a single tuft, also black, and a little shorter. On the upper side are four compact tufts or tussocks of white or cream color, each on a separate segment of the larvae. The head is coral red. In general appearance the larvae is dark gray, with a broad, velvety black band on the back, bordered with yellow stripes and yellow below.

After passing thru the intermediate pupa or resting stage, the caterpillar becomes the mature insect, or moth. Only male moths have fully developed wings. The males are ashy gray in color, the wings expanding to about 1⅜ inches. The fore wing is crossed with undulating bands of darker shades and bears a conspicuous white spot.

The White-marked Tussock-Moth

1 *Hemerocampa leucostigma.*

The female has only rudimentary wings and is hairy, stout, and light grayish in color. She is unable to fly and mating therefore takes place wherever the female emerges from the pupa.

The eggs are deposited in conspicuous masses of about 400 on the cocoon where the female emerges. These are nearly spherical in shape, and yellowish in color. The whole mass is covered with a frothy substance.

APPEARANCE DURING THE SEASON

This insect spends the winter in the egg stage. The white egg masses are often conspicuous objects on tree trunks and even on the sides of buildings in localities where the larvae have been exceptionally common. Young caterpillars hatch in Iowa in June. In 1908 these were observed by the writer at Shenandoah, June 6, for the first time that year. By June 15 larvae were common at the same place.

Egg mass of White-marked Tussock-Moth

After feeding about a month, the caterpillar forms its brownish, silken cocoon on the bark of trees, on twigs or elsewhere. It then transforms, first to the intermediate pupa stage, and then to the moth. Consequently, in Iowa another lot of eggs are deposited in midsummer and later, in August and September, a new lot of caterpillars appear. These feed and mature late in September, the insect passing the winter in the egg stage.

FOOD PLANTS

The white-marked tussock-moth is best known as a shade tree insect and is most destructive to such trees as elm, soft maple and linden. The larvae feed on many other plants, among which are the poplar, willow, oak, ash, catalpa, boxelder, birch, horse chestnut, and other trees. The insect is frequently found on apple foliage and the writer once observed a caterpillar feeding on a blade of corn.

CONTROL MEASURES

Control measures may be directed in two ways; against the eggs and against the caterpillars.

The destruction of egg masses during the colder months is a most important measure. These masses are conspicuous and may be easily collected by hand. In fact, school children in some localities have been encouraged to gather these and are paid for so doing. Those egg masses which are out of each can be treated with creosote applied by means of a sponge soaked in this material and attached to a pole.

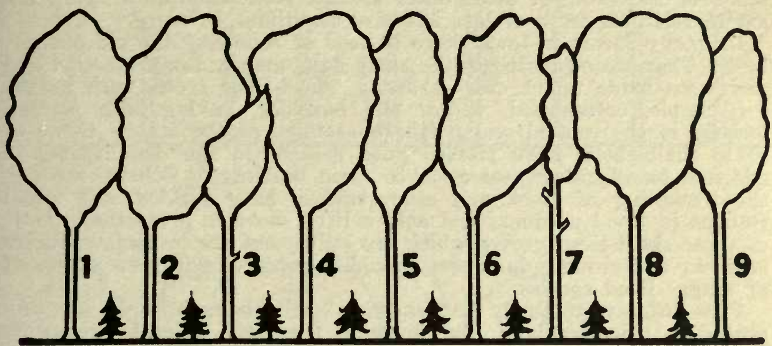
In spring, trees not infested with this insect may be protected by placing

around the trunk a band of tanglefoot fly paper. A special preparation known as ''tree tanglefoot'' is desirable for this purpose. The bands should be about 9 inches wide and placed at a convenient height on the trunk. These bands will not protect trees already infested, and where branches intermingle there is always a chance for outside infestation regardless of bands.

The application of arsenical poisons to the foliage of trees already infested with the larvae is also recommended. The main reliance, however, should be placed on the destruction of egg masses and the banding of trees. Spraying is not only expensive but difficult to accomplish satisfactorily in case of large trees. Lead arsenate is preferable for this purpose. This should be used at the rate of five pounds of lead arsenate paste to 50 gallons of water.

March, 1916 Circular No. 27

RENEWING THE SHELTERBELT



In cover figure the new generation of trees have grown for five years under the old stand. Even shade-enduring trees, although getting a start, will not make a satisfactory growth in the dense shade of other trees, consequently the old stand should be opened up either gradually or at one operation.

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Forestry Section

Ames, Iowa

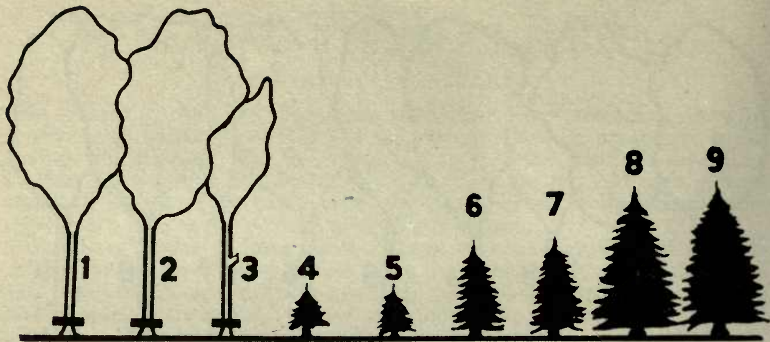

Fig. 4. After 15 years, the remaining rows, 1, 2 and 3, are cut out and replanted.

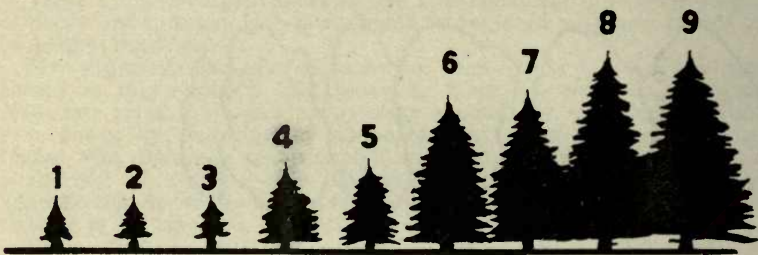

Fig. 5. After 20 years, the last rows, 1, 2 and 3, are 5 years old and 8 and 9, are 20 years old. The regeneration of the shelterbelt is completed.

Third Step: After another five-year period has elapsed, cut out rows 4 and 5 and replant them. This leaves but three rows of the old trees for giving protection. By this time, however, if broadleaf trees or fast-growing evergreens have been used for planting, the trees in rows 8 and 9 should be large enough to give good wind protection themselves, thus reinforcing the old rows remaining.

Fourth Step: After the third five-year period, cut out the remaining three rows of old trees and replant. If the plantings are successful, the regeneration is completed.

USE OF THE METHOD FOR DIFFERENT SHELTERBELTS

The method of regeneration from one side is adaptable to groves of any species, since the successive cuttings progress in a way to give an abundance of light to the new growth, no matter what the original grove is composed of.

Cottonwood: The cottonwood matures at an age of 35 to 40 years. It requires an abundance of light for growth and, as a result, stands of this species are relatively open. Many of these shelterbelts in the state are 35 to 40 years old and, under usual conditions, will last long enough for the application of this system of regeneration.

There will be difficulty in using the old trees for lumber, since it usually would not be profitable to bring in a portable sawmill every

few years for cutting up small amounts of lumber. However, where the plantation is large enough, the lumber can be used profitably for rough construction work on the farm. Round, split or sawed fence posts made from cottonwood trees will last for 25 years if given a good treatment with creosote.* In most sections of the state the wood has a ready value for fuel on the farm.

Soft Maple: Soft maple trees are quite tolerant of shade and, consequently, grow in a dense stand. The dense shading on the interior of the average soft maple grove makes it impossible to grow successfully under the old stand any except the most shade-enduring trees. However, under the regeneration method just described, the new trees are established outside of the grove proper, where shading interferes but little. Like the cottonwood, the soft maple is a short-lived tree and regeneration by this method should begin by or before the fortieth year if possible.

The relatively small number of maple trees removed periodically under this system should generally be used for fuel or fence posts. Soft maple fence posts when given a treatment of creosote, at a cost of 10 to 15 cents per post, will last for a period of 25 years.

Willow: The willow is also short-lived and the application of this method should be begun preferably before the trees are 35 years old. The willow sprouts persistently from the stump after the trees are cut down and usually considerable trouble is experienced in killing the sprouts. If the trees are cut in August, instead of in the winter, very few sprouts appear, and if these are promptly removed the stumps soon die. Under present conditions the willow has few uses except for fuel. However, after treatment with creosote, willow fence posts last for a long period of years and the wood from the old shelterbelt might profitably be used for this purpose.

Boxelder: Boxelder trees, although moderately rapid in growth, are always crooked, of small size and very short lived. They have little value except for wind protection. The regeneration by the method just described, should be begun as early as possible, even in young plantations. In old plantations (35 years), it is sometimes desirable to renew the grove by a quicker method, such as the clear-cutting system (see figs. 11, 12, 13 and 14). Use the trees removed for fuel or, if straight enough, for fence posts. Posts treated with creosote last as well as the cottonwood, soft maple and willow after treatment.

TREES ADAPTED FOR PLANTING

Practically any tree suited to the climatic, soil and moisture conditions can be safely regenerated under this first system. The selection of the variety or varieties to be used must be largely governed by the uses to which the shelterbelt is to be put and also by the likes and dislikes of the owner. If the new grove is to serve efficiently as a shelter from the winter winds, at least a portion of the new planting should consist of evergreens. If it is to serve also as a source of fuel, fence posts, and lumber, the trees best adapted for these purposes should make up a part of the new plantation. Care should be exercised in mixing species, so as not to have a row of fast-growing trees, such as some of the hardwoods, overtop and shade out previously planted rows of a slower growing, intolerant species such as the Austrian, Scotch, or western yellow pines.

The following evergreen trees, when only one species is used, are adapted for planting in regeneration from one side:

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*See Bulletin 158, Iowa Agricultural Experiment Station. "The Preservative Treatment of Fence Posts."

White Pine: One of the most rapid-growing evergreen trees. Will grow on any except a poorly drained soil. A good windbreak tree when spaced 10 feet apart, in rows 12 feet apart. Produces saw lumber in 40 to 50 years. For this purpose it should be spaced 8 x 8 feet apart. Will endure a slight amount of shading when young.

Red Pine: Fairly rapid growth. Good for any but a wet soil. Will not endure shading.

Austrian Pine: Very hardy. Good for dry situations. Slower in growth than the white pine. Will not stand shading.

Western Yellow Pine: A hardy western tree suitable for dry situation. Similar to the red pine but of slower growth. Very intolerant of shade.

Norway Spruce: The best spruce for Iowa planting. Has a dense foliage and branches to the ground. Will stand shading. Should not be planted on very dry situations.

White Cedar: A shade-enduring evergreen of slow growth, making a good shelterbelt tree. It is not suitable for dry upland planting but will endure rather wet soils.

Red Cedar: A good windbreak tree. Suitable for very dry situations and soils of poor quality. Should not be planted near apple trees because of fungus trouble. Will stand shading.

European Larch: A tall, straight tree suitable for planting on good soils. Intolerant of shade. Not best for winter protection, since it sheds its leaves annually. Produces good pole timber.

Other evergreens which might be planted, but which are less desirable than the above, are the jack pine, Scotch pine, white spruce, and Douglas fir.

Broadleaf trees which might profitably be planted are the following:

Cottonwood: The fastest growing tree in Iowa. Good for quick results, but short-lived. Intolerant of shade. Will make fence posts* in six years and saw logs in 25 years on good soil.

Soft Maple: Fairly rapid grower. Will stand close spacing, and some shading. Short-lived. Can be utilized for fence posts (creosoted) and for fuel.

Hardy Catalpa: A small tree requiring full light. Good for fence posts. Should not be planted on exposed situations in northwestern Iowa without protection of other rows of trees.

Black Walnut: A fairly rapid grower, forming an open stand. Requires a moist soil. Is very intolerant of shade. Valuable for lumber but does not make a very effective windbreak tree, due to the thinness of its foliage.

Honey Locust: A fairly rapid grower. Intolerant of shade. Makes good posts.

Osage Orange: Not hardy in northern half of Iowa. A good fence post tree. Intolerant of shade.

Russian Mulberry: A small tree, giving protection close to the ground. Very tolerant and drought resistant. Not hardy in northern Iowa. Wood very durable.

Green Ash: A medium-sized tree of moderate growth and quite hardy. Makes fair fence posts.

A large number of hardwood trees might be added to the above list, but in planting, care should be taken to select only those trees adapted to the local climatic and soil conditions.

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*Cottonwood posts are not durable unless treated with a preservative.

COMBINATIONS OF SPECIES FOR PLANTING

Various combinations of trees may be planted under this system of regeneration from one side, but, as a rule, two or three species are sufficient. If the rows are to be of different varieties, the principal care should be to see that the rapidly-growing hardwoods do not overtop and suppress the slow-growing trees. The intolerant evergreens, being of slow initial growth, are in more danger of being overtopped than the hardwood trees.

The following are some of the combinations which might be used:

Combination No. 1. Rows 8 and 9, white pine; rows 6 and 7, Norway spruce; rows 4 and 5, European larch; rows 1, 2 and 3, white pine.

Combination No. 2. Rows 8 and 9, white cedar or Norway spruce; rows 4, 5, 6 and 7, white pine, red pine or Austrian pine; rows 1, 2 and 3, white cedar or Norway spruce.

Combination No. 3. Rows 8 and 9, European larch (bare in winter); rows 6 and 7, white cedar or red cedar;* rows 4 and 5, Norway spruce or white spruce; rows 1, 2 and 3, cottonwood.

Combination No. 4. Rows 8 and 9, white cedar, Norway spruce or white pine; rows 6 and 7, red pine, Austrian pine, western yellow pine, or Douglas fir; rows 4 and 5, Norway spruce or white cedar; rows 1, 2 and 3, hardy catalpa.

Combination No. 5. Rows 8 and 9, white pine; rows 6 and 7, Norway spruce or white cedar; rows 4 and 5, cottonwood; rows 1, 2 and 3, green ash, or Russian mulberry.**

VARIATIONS IN THE METHOD

In this first regeneration process, the five-year period between successive cuttings need not necessarily be adhered to. The period might be reduced to three years or less. In the case of a shelterbelt composed of three or four rows of old trees, only one row should be cut at a time, unless the trees are in very poor condition.

REGENERATION FROM TWO SIDES

In this method it is also the purpose to secure a new growth of trees without sacrificing entirely the efficiency of the windbreak. By reference to the diagrams in the figs. 6 to 10, it will be noted that instead of a gradual removal of the trees from one side, as was the case in the first method, single rows are taken from each side at intervals of five years. The time between the first and the last planting is the same as in the first method of cutting—15 years.

Figures 6 to 10 show how the cuttings should proceed. In the case illustrated, it is assumed that the shelterbelt is composed of nine rows of trees, most of which will last through the regenerative period of 15 years.

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*Red cedar should not be planted if apple trees are in the vicinity because of fungus trouble.

**For Southern Iowa only.

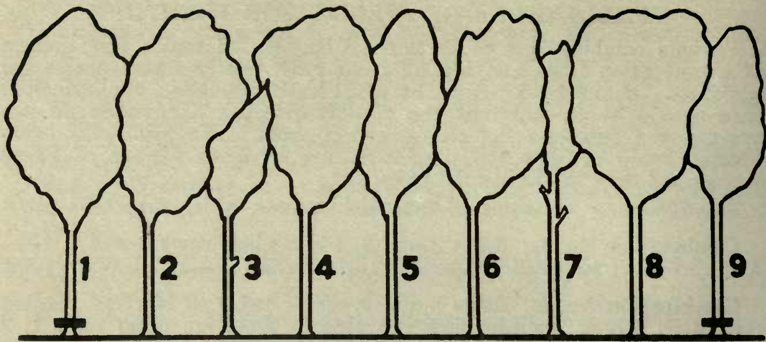

Fig. 6. At the beginning the two outside rows, 1 and 9, are cut out and replanted the same year with young trees of the new species.

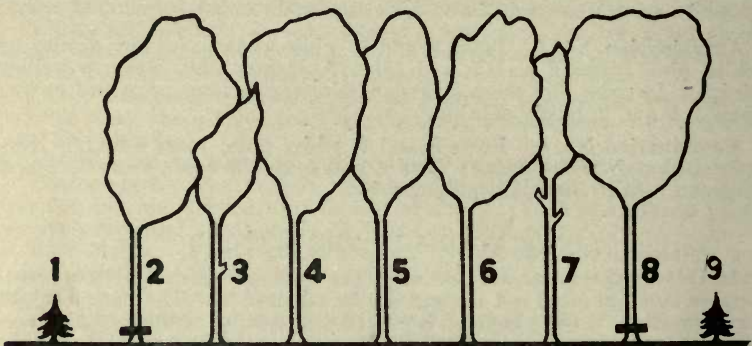

Fig. 7. After 5 years, rows 2 and 8 are cut out and planted with new trees; the trees in rows 1 and 9 are 5 years old.

At the beginning, rows 1 and 9 of the old plantation are cut out and replanted to the new species. Five years later rows 2 and 8 are taken out, and after another period of five years, rows 3 and 7 are removed. At the last cutting, rows 4, 5 and 6 are replaced with young trees. It will be seen that fair protection from the wind is afforded by the old trees, even up to the last cutting, and by this time some of the newly-planted trees should be sufficiently high to give some protection.

USE OF THE METHOD FOR DIFFERENT SHELTERBELTS

This second method should be almost as successful in regenerating short-lived shelterbelts of cottonwood, soft maple, willow and boxelder, as the method of planting up from one side. There is one slight disadvantage; the new trees planted directly north of the old rows will receive less light than those planted to the south, consequently, some care should be exercised in the selection of species for planting. The shading is most severe in the cases of soft maple and boxelder shelterbelts, since the foliage of these trees is much more dense than that of the cottonwood or willow.

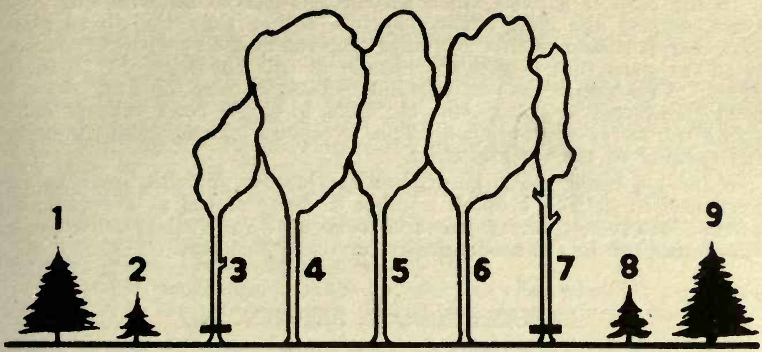

Fig. 8. After 10 years, rows 3 and 7 are cut from the shelterbelt and replanted.

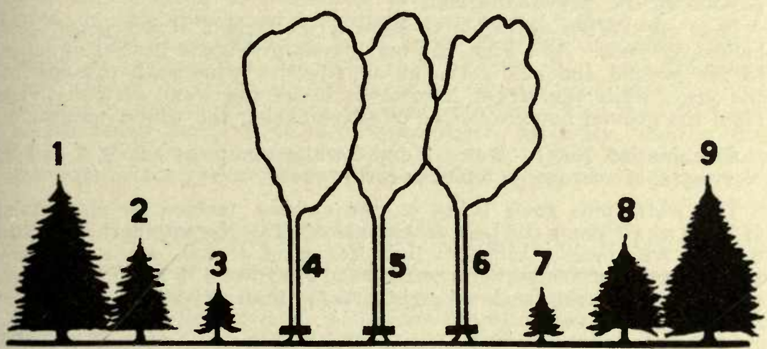

Fig. 9. After 15 years, the remainder of the old planting, rows 4, 5 and 6, are cut out and replanted.

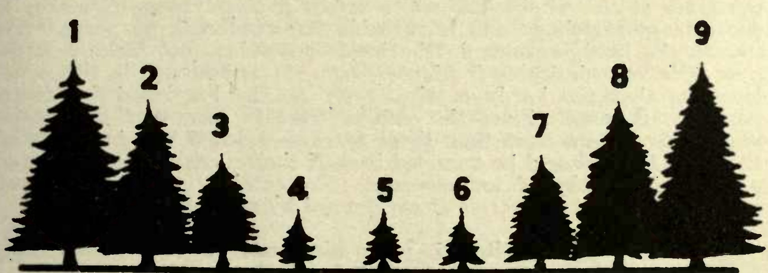

Fig. 10. After 20 years the youngest trees, in the interior of the grove, rows 4, 5 and 6, are 5 years old and the oldest, rows 1 and 9, are 20 years old.

In the case of groves which should be replaced at once with new trees, employ the clear-cutting system rather than the above plan. However, it is seldom that a plantation, even of the short-lived species, is so far gone that it will not remain in fair condition for 10 to 15 years. This method has certain disadvantages over the first, since it is more difficult to cut out the old trees in single rows without damaging the newly-planted ones. This is especially true when the original spacing of the trees is close.

If the old timber is to be utilized for lumber, difficulty may be experienced in getting a small number of trees sawed at a reasonable price. However, if the woodlot is to be used for fuel or fence posts, the timber can be cut economically for these purposes.

SPECIES USED IN REPLANTING

The list of species suitable for planting under this method is almost identical with the one given under the preceding first system. It should be borne in mind, however, that the newly planted trees to the north of the old rows will receive less light than those planted on the south side. As a result, if this shading appears to be excessive, trees which are somewhat tolerant of shade should be selected for this portion of the new shelterbelt.

It is very often desirable to have a shelterbelt of evergreen and hardwood trees. As a rule, the evergreens give good protection close to the ground and also serve as an effective windbreak throughout the year, while the larger hardwoods break the wind, at a distance from the ground but are not as effective during the winter months.

Combination No. 1. Rows 1 and 9,white pine; rows 2, 3, 7 and 8, Norway spruce; rows 4, 5 and 6, cottonwood.

The white pine rows being on the outside, receive an abundance of light at all times for best development. The Norway spruce on the interior will receive sufficient light for good growth, since they are very tolerant of shade. The cottonwoods in rows 4, 5 and 6, although planted last, would reach a height greater than any of the evergreen trees in a few years.

Combination No. 2. Row 1, Norway spruce; row 9, white pine; rows 2 and 8, white cedar; rows 3, 4, 5, 6 and 7, hardy catalpa.

The white pine trees in row 9 are not only effective as a windbreak, but also make a very beautiful row to face the farm buildings. The Norway spruce used in row 1, branches very close to the ground, has dense foliage, and, consequently, would be very effective in breaking the force of the wind. The white cedar, if closely spaced, makes a dense mass of foliage and is valuable for windbreak purposes. Although the hardy catalpa in the inside rows does not make a large tree, it is very desirable for fence posts. It is assumed in this combination, that the hardy catalpa rows can be harvested for fence posts in 12 years. Since the catalpa trees in rows 4, 5 and 6 are planted five years later than those in rows 3 and 7, the branches of the older trees should be trimmed back if there is danger of the later planting being shaded too severely. The catalpa is very intolerant of shade and will not thrive if overtopped by adjoining trees.

Combination No. 3. Row 1, white pine; row 9, white cedar; rows 2, 3, 7 and 8, Norway spruce; rows 4, 5, and 6, white pine.

The white pine in the interior rows, although planted last, is sufficiently rapid in growth to prevent its being overtopped by the

adjoining rows of Norway spruce, although the latter are planted five years earlier.

Combination No. 4. Rows 1 and 9, white cedar; rows 2 and 8, Norway spruce; rows 3, 4, 5, 6 and 7, cottonwood.

The evergreens on each flank of the shelterbelt will give efficient protection against the wind close to the ground and, at the same time, will give a pleasing effect to the windbreak both in summer and winter time. The interior of the plantation will, in a few years, not only break the force of the wind at some distance from the ground, but also be a profitable source of saw timber or fuel.

Combination No. 5. Row 1, white pine; row 2, white cedar; row 3, white spruce; rows 4, 5 and 6, red cedar;* row 7, Jack pine; row 8, western yellow pine; row 9, European larch.

The above combination makes an effective shelterbelt of coniferous species. The larch trees in row 9 shed their leaves during the winter.

VARIATIONS IN THE METHOD

It will seldom happen that the plan illustrated under this method will exactly fit conditions found in other shelterbelts. The method should be considered as suggestive and altered to suit local conditions. In the case of a shelterbelt which has only three or four rows, it would no doubt be preferable to use the system of regeneration from one side, taking out one row at each period instead of two rows. In the case of a plantation much wider than the one illustrated, it might be preferable to take two rows of trees at a time from each side instead of one row. There is no necessity of adhering to a uniform period of five years between cuttings. This may be either lengthened or shortened to suit convenience or necessity. On the other hand, a plan should be prepared and the work should follow a definite schedule or the regeneration will unquestionably prove a failure.

REGENERATION BY CLEAR-CUTTING

The method of clear-cutting is only employed when the windbreak can be dispensed with while the new stand of trees is growing, or where the old timber is in such poor condition that it must be renewed at once. Under such conditions, it is advisable either to cut everything on the plantation or to leave only a row or two to give some protection for a few years.

Under this system it is advisable, where conditions will permit, to leave two rows of the old trees after the first cutting, these rows to be removed during the second and third steps, respectively, in the regeneration process. (See figs. 11, 12, 13 and 14.)

The system has several advantages. In cases where the old plantation is to be cut into lumber (cottonwood for example), the trees can be sawed at a minimum cost, since most of the plantation is removed at one time. In addition, by removing practically all of the stand at once and replanting, there is no damage to the new stand of trees. On the other hand, where the timber is to be used for fence posts and fuel, it very frequently happens that there is not

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*Red cedar should not be planted in the vicinity of apple trees.

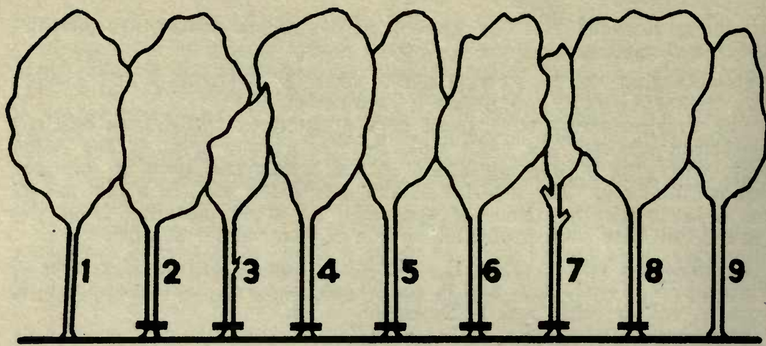

Fig. 11. At the beginning, rows 2, 3, 4, 5, 6, 7 and 8 are cut out. The rows are replanted the same year to either evergreen or broadleaf trees. The original trees in rows 1 and 9 are left temporarily for shelter and also to give some protection to the new crop of trees.

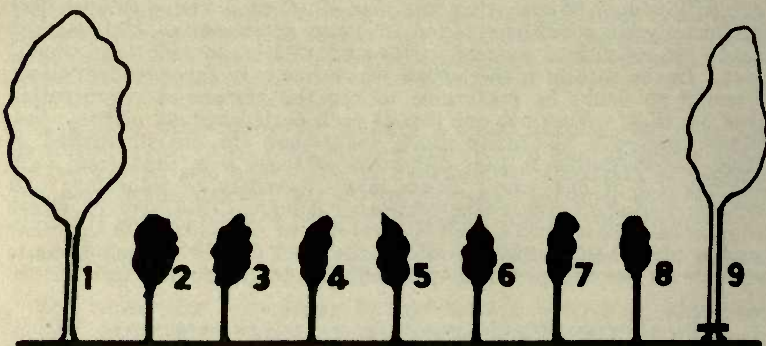

Fig. 12. After 5 years the trees in row 9 are cut out and replanted. The old trees in row 1 preserve partly the effectiveness of the shelterbelt at some distance from the ground. If the interior trees are of the broadleaf class the effectiveness of the shelterbelt would eventually be increased by planting evergreens in row 9.

a market for this material except on the home place. Consequently, it would entail a great waste of material, through decay, to store up for a number of years a supply of fuel or posts made up of undurable woods.

At the beginning of the regeneration period, all except the two outside rows of trees are removed and replanted. After five years' time, the south row (no. 9) is removed and replanted. At the close of another five-year period the last row of old trees (no. 1) is replaced. The outside rows being more thickly branched will give fair protection against the wind. In case the trees are in such poor condition that they will not last for even a few years, it would then be desirable to take out all of the old trees at the first cutting. Under such circumstances, a portion of the new growth should be made up of the most rapidly growing trees available, in order that the grove may become effective against the wind as soon as possible.

The clear-cutting method, from a cultural standpoint can be more generally applied than any of the other systems suggested. In a pure plantation, established at one time, there is less danger of excessive crowding and overtopping, since the trees are equal in rate of growth and shade-enduring qualities. If the new shelterbelt is to

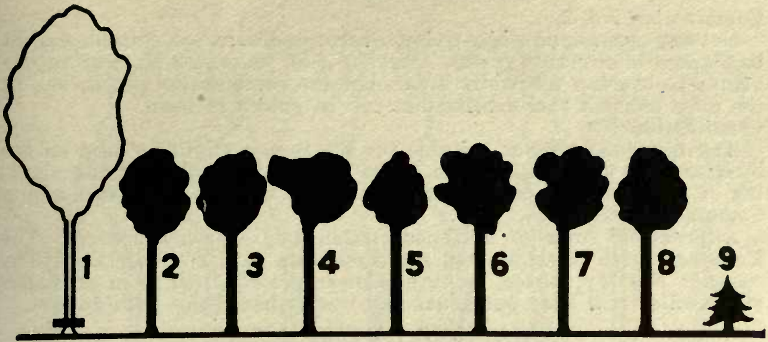

Fig. 13. After 10 years the newly planted trees are large enough to permit the removal of the remaining old trees, row 1, without injury. This row should be planted the same year.

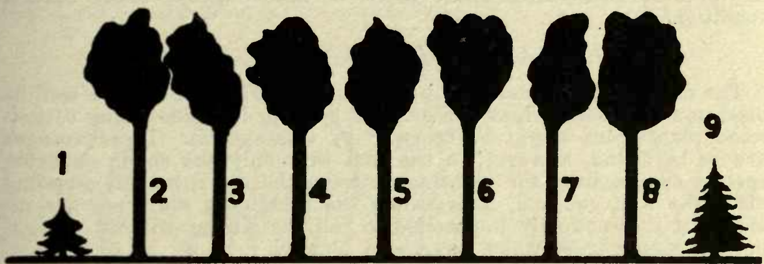

Fig. 14. After 15 years the regenerated shelterbelt should give good protection.

be composed of different species, care must be exercised in the selection of combinations, to prevent overtopping and killing the slower growing or intolerant trees.

This system should be applied to cottonwood, soft maple, willow and boxelder shelterbelts which are too old or degenerate to be satisfactorily regenerated by one of the slower methods, or where the protective feature of the grove is not of great importance.

SPECIES USED IN PLANTING

When one species is to be used throughout the entire shelterbelt, any tree which is suited to the climatic, soil and moisture conditions of the locality may be used. The following is a partial list of trees which might be used: Cottonwood, hardy catalpa, soft maple, hard maple, black walnut, red oak, white pine, red pine, Austrian pine, western yellow pine, Norway spruce, European larch, red cedar, white cedar.

COMBINATIONS FOR REPLANTING

Combination No. 1.

The Norway spruce, white cedar or red cedar might be alternated with the cottonwood or other thin-crowned, fast-growing species. These evergreens are tolerant of shade and would make a fair growth under the light shade of trees such as the cottonwood.

Combination No. 2.

Norway spruce and white cedar, where conditions are suitable, might be planted in alternate rows. After 30 to 35 years, the Norway spruce begins to overtop the white cedar, but the combination makes one of the most efficient shelterbelts that can be grown in Iowa.

Combination No. 3.

Any broadleaf species suitable for the region might be used on the interior rows of the plantation, these rows to be flanked by the planting of any evergreen suiting the locality, in the outside rows 1 and 9.

Combination No. 4.

Alternating rows of European larch and Norway spruce. The European larch when planted alone makes a rather open stand. The tolerant Norway spruce, being of slower growth, will form an under story which will keep out grass and weeds, benefiting both species.

VARIATIONS IN THE METHOD

One block, making up from one-fourth to one-half of the plantation, might be renewed in one year, and the balance of the plantation in the years immediately following. This would distribute the planting over several years, which might be advantageous under certain conditions.

REGENERATION BY ALTERNATE ROWS

The method of regeneration by planting alternate rows may well be used in shelterbelts where the original spacing is wide. Many cottonwood plantations might be renewed by this system. Disadvantages are to be found, however, in the fact that only the shade enduring species can be used for planting between the old rows left standing after the first cut and, later, when the remaining old trees are removed it is practically impossible to fell the timber without damaging the young trees which have been planted.

Under this system the entire stand of old trees is removed in two cuttings. The second cutting should generally follow the first after about 10 years, but this period can either be shortened or lengthened to suit conditions (see figs. 15, 16 and 17.) Fairly good windbreak protection will be afforded until time for the last cutting of the old timber. At this time, unless the period between cuts has been of considerable length, the efficiency of the windbreak is likely to be impaired for a number of years, inasmuch as the tolerant trees which are used in replanting are generally of slow growth and will not be tall enough to give much protection against the wind in a period less than fifteen or twenty years.

This system could be used in certain cases in cottonwood or willow plantations which are rather open. As a rule, it could not well be used in dense plantations of either soft maple, boxelder or other species forming a very heavy shade. For the reasons already given, this system is not as desirable as some of the others already described.

SPECIES USED IN REPLANTING

A list of trees suitable for replanting by this method will be restricted, except under exceptional cases, to those which are tolerant of shade. This list will include:

Norway spruce	Hard maple
White cedar	Soft maple
Red cedar	Basswood
White spruce	Boxelder

In no case should trees intolerant of shade be used except where it is evident that they will not become overtopped by the adjoining trees. It might sometimes be possible to use a fast-growing, intoler-

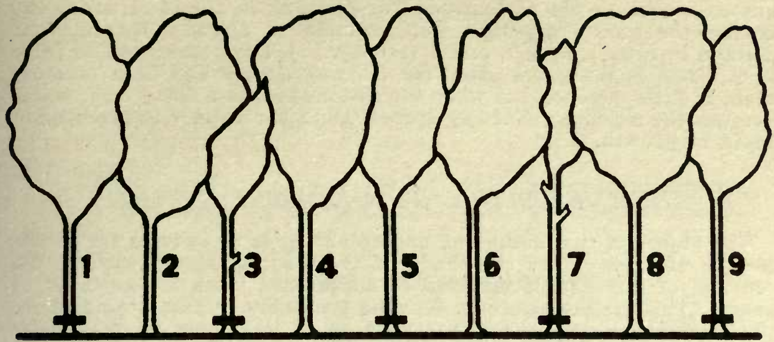

Fig. 15. Alternate rows, 1, 3, 5, 7 and 9, are removed at the start. Also remove broken, suppressed and otherwise defective trees in rows 2, 4, 6 and 8. Replant the open rows and blank spaces the same year. Only shade-enduring trees should be used except for the outside rows.

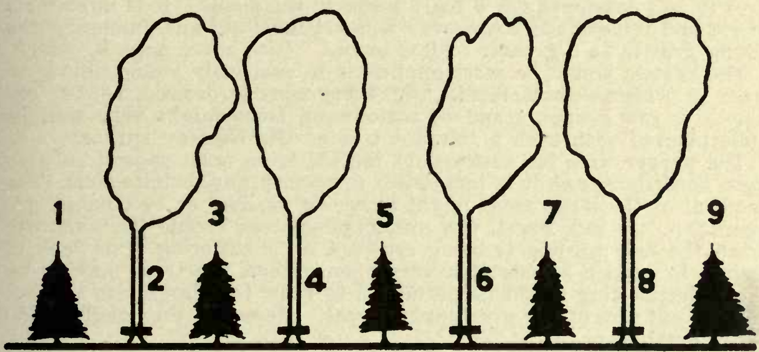

Fig. 16. At this period the regeneration is only partially completed. The remaining trees in rows 2, 4, 6 and 8 should be removed and replanted.

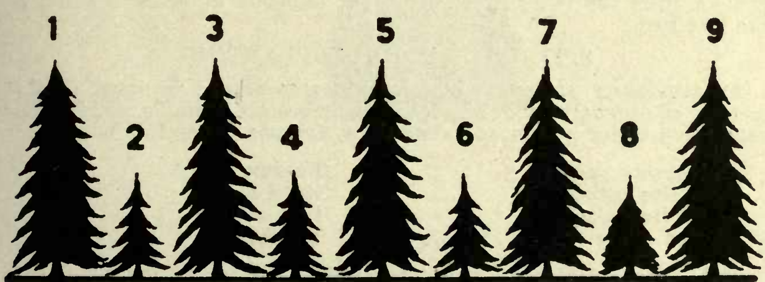

Fig. 17. The trees of the first replanting are 20 years old, rows 1, 3, 5, 7 and 9, and those of the second replanting are 10 years old, rows 2, 4, 6 and 8.

ant tree, such as the cottonwood, for planting in the rows taken out during the second cutting. For example, if Norway spruce were planted in rows 1, 3, 5, 7, and 9 (see fig. 17), and cottonwood in rows 2, 4, 6 and 8, ten years after the Norway spruce had been planted, there is little question but what the cottonwood, in a few years, would overtop the adjoining Norway spruce, since the former is much more rapid in growth.

REGENERATION BY UNDERPLANTING

The object of the method of underplanting is to provide for a new growth of trees under the shade of the existing stand, without the removal of any except diseased or suppressed trees for a period of years. This method can only be used profitably in plantations where the original spacing was rather wide, or at least only in plantations where there is some direct light reaching the ground.

It is evident that in planting new trees between the old rows without the removal of any of the old stand, only the most shade enduring species can be used. This point should be thoroughly kept in mind, since a considerable loss and much delay might result in underplanting with the wrong species. Aside from this the greatest disadvantage is in the removal of the old stand of trees after the young growth has developed for 5 to 10 years in the shade. It is impossible to cut and remove the large trees without breaking and damaging the young growth to a greater or less extent. (See cover page figure.)

The system would be most applicable to relatively young stands of trees in which a reinforcement of evergreens is desired, as, for example, a young open stand of cottonwood trees might very well be underplanted with such a tolerant tree as the Norway spruce.

The proper time for cutting out the old trees must depend entirely upon conditions, and it is impossible to specify any definite time. The removal of the large trees might either be gradual or be done at one operation. In any event, the overtopping trees should be taken out when the new growth is being crowded or is suffering from lack of light. In certain stands of a very open nature, the trees making up the underplanting might be permitted to grow to a large size without cutting out any of the overtopping trees. However, this would be an exceptional case.

The application of this method to groves of different species depends more on the openness of the stand than on the species itself, since the system could be applied to any grove if the old trees were widely spaced. The system, as a rule, will more generally apply to cottonwood and willow plantations than to soft maple and boxelder groves, since the two former are never found in as dense a stand as the last two.

SPECIES FOR UNDERPLANTING

As previously stated, only tolerant trees should be used in this method of regeneration. The following trees are suitable within their range and under proper soil conditions, for use under this method:

Norway spruce	Basswood
White spruce	Hard maple
White cedar	Soft maple
Red cedar	Boxelder

The above list of trees might be used in various combinations successfully.

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THE AMES FORESTER

Published Annually By

The Forestry Club

of the

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Ames, Iowa

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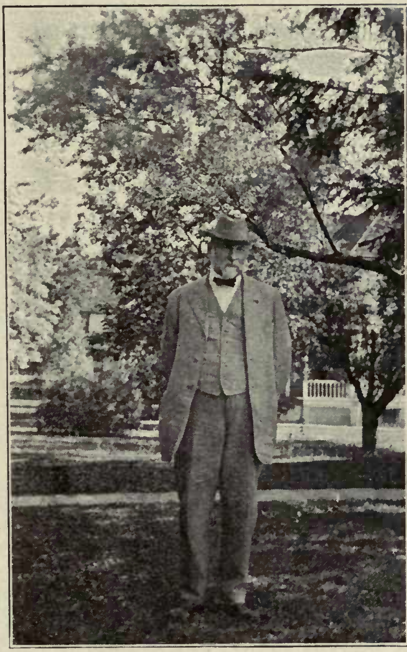

Doctor Louis Hermann Pammel

To
Louis H. Pammel,
who with untiring de-
votion inspires in the
student a desire for an
intimate knowledge of the
plantworld and who thru his
genial personality and zealous
interest in forestry has won
the high esteem of the stu-
dents, we, the Forestry
Club of Iowa State Col-
lege, respectfully ded-
icate this publica-
tion.

"HOME SONG OF THE WEST"

Anonymous

It came over me on Broadway, in the splatter and the mud
And the blasted office-building seemed to mock me where I stood,
For I saw the Sapphire Mountains girdling round the valley plain,
And I heard the cattle lowing on the ranges once again,
Heard the far coyote's cry,
Saw the tumbling weed blow by,
And the light upon the ledges where the sunning rattlers lie,
It was clear before my eye
As the daylight in the sky
And I swore to see the mountains once again before I die.

You may talk of quiet homesteads in the Immemorial East,
And the still New England village, where the weary years have ceased
Footing up the bills of trouble; but the only place for me
Is below the naked mountains, where the lupines used to be,
Oh! it is far away to seek
By the banks of Sweet Grass Creek
With the shadows falling purple down the slopes of grassy Peak
Where the little roses bloom
In a passion of perfume,
And a man has light and air, and a man has rest and room.

I can see the brown stock saddle, I can hear the punchers swear
At the raving staying pony rising end-wise in the air;
I can see the tough flank redden, where the iron rowels score,
And the strong brown fingers plucking at the choking hackamore.
I can see each stroke that's struck
As the brute begins to buck
And the buster settles to it, and sets in to ride amuck.
Crack! comes the downward slashing quirt;
Thud! the bunched hoofs hit the dirt;
But the boy's still sticking to him like a shirt-tail to a shirt.

Oh! I'll swing away to the westward on the new Milwaukee mail,
And they'll drop me off at Two Dot, and I'll hit the open trail.
And I'll cleanse my soul of cities, as they cleanse a sword of rust,
And the watch-word of my venture shall be "open air or bust!"
Oh! my heart will be a feather
When we are riding home together!
Oh! the hot rejoicing horses! Oh! the smell of sweaty leather!
Oh! its home we'll ride again
O'er the God-created plain
To the snows that are forever, to the summit that remains.

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The Forestry Club of Iowa State College.

Progress of Land Classification in the National Forests

E. A. SHERMAN, '96
Assistant Forester, in charge of Lands, U. S. Forest Service.

The growth of the National Forests in the public land states of the west was largely a spasmodic mushroom growth. The first Forests were created under the authority of the Act of 1891, which provided merely for reservation without administration. A sudden increase in these areas, through Presidential proclamation, was at first set aside by Congress but resulted in the passage of the Act of June 4, 1897, which provided for the administration and protection of the areas reserved. The great body of timber land under Government ownership today was withdrawn during the ten years following the passage of that Act, the National Forest area, inclusive of Alaska, reaching its maximum April 20, 1910, with a total of 167,710,956 acres, gross.

This vast acreage represented approximately 160 Forests which had been carved out of the public domain with a full free hand. Many of the earlier Forests created in the Northwest were established without field examination. These, however, did not represent in the aggregate more than about 30,000,000 acres, and embraced the first Forest reserves created under the administration of the General Land Office of the Department of the Interior. Afterwards all areas were examined in the field by officers from the Bureau of Forestry, then in the Department of Agriculture, and, excepting for the work of boundary examinations at that time, in no way connected with the administration of the Government's Forests. The work was done quickly. The examiners were young, energetic, honest, and thorough. What they lacked in field experience they made up in enthusiasm and earnestness. Each examiner was expected to cover about a township a day while in the field, and for several years these boundarymen waged a strenuous campaign of cruising and exploration, having for

its object the control and ownership of the Nation's forests. On the other side, was a large number of lumbermen, with their cruisers and dummy entrymen, who were seeking to secure timber to furnish a future supply of lumber for the future big sawmills of the Northwest. In other places big cattlemen employed dummy entrymen in order to secure ownership and control of timber, water, and range. The matter was terminated by the issuance of a series of proclamations March 1-4, 1907, inclusive, at which time approximately 17,000,000 acres of the most valuable timberland in the Northwest was added to the National Forests.

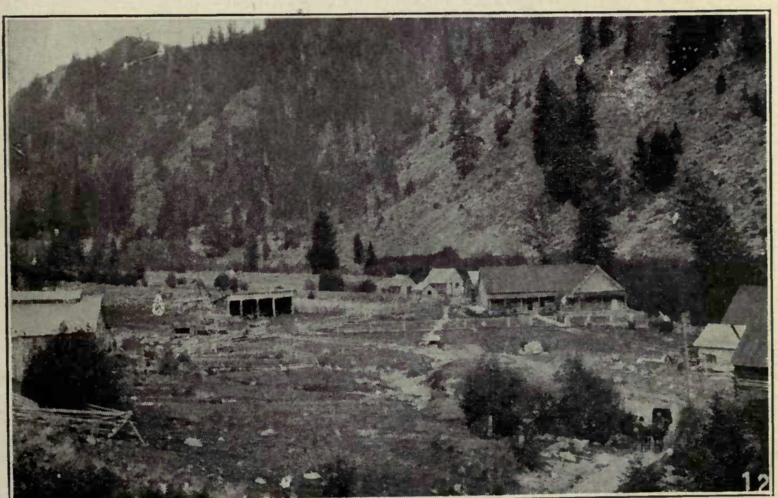
This boundary work was the first rude attempt at classifying public lands for National Forest purposes. It was followed by the Forest Homestead Act, which was passed June 11, 1906, and provided for the listing and opening to homestead entry of all lands within the exterior boundaries of the National Forests found to be chiefly valuable for agriculture. This law authorized and empowered the Secretary of Agriculture, upon application or otherwise, to examine and list with the Department of the Interior for homestead entry in tracts not exceeding 160 acres in area and not more than one mile in length, lands in the National Forests which in his opinion are chiefly valuable for agriculture and not needed for public purposes, and the listing of which will not injure the National Forest interests.

This law was a boon to the mountaineer of the west, in that it provided a means whereby land might be filed upon and patent secured in advance of the extension of the regular public land surveys. It had another feature particularly adapted to rough, mountain regions in that it provided for metes and bounds surveys, thereby making it possible to secure the good land, where conformity to 40 acre legal subdivisions might throw considerable poor, rough land into the 160 acre total.

The first applicants under the Forest Homestead law were usually ''squatters'', or settlers who had taken up land before the forests had been set aside for public use. These naturally divided themselves into two classes: (1) Those who had settled for farm purposes; (2) Those who were after the timber. They were at the two extremes. The agriculturist had the best farm land in the Forest, since he was early on the ground

By courtesy of U. S. Forest Service.

A ranch established under the Forest Homestead Act on the Payette River in Western Idaho. The homesteader is living in a tent during the construction of a log house. It is 30 miles from the railroad.



By courtesy of U. S. Forest Service.

A ranch situated in central Idaho near the mouth of a creek emptying into the Salmon River. It is about 75 miles from a railroad and was established under the Forest Homestead Act.

and took his pick. It was easy to handle his case, for his land was really farm land. The timber speculator had the most valuable tract of timber, for the same reason, because he had his pick. His land could not be classified as "chiefly valuable for agriculture", and he has consequently remained dissatisfied with the workings of the law.

The applications from outsiders have, in the main, been from people who were honest in their desire for farm land. For a time the belief was cherished that this represented a form of timber homestead, another opportunity to get a stake at Uncle Sam's expense, but that misapprehension was soon disposed of, and only in exceptional cases are heavily timbered lands now applied for.

The classification of land which has been done by the Forest Service in carrying out the provisions of the Forest Homestead Act has been exceedingly interesting because of its infinite variety and the elements of human interest which it involves. Every forest has been searched from foothill to timberline for areas suitable for farm purposes. Up to June 30, 1915, the last date for which total figures are available, a total of 18,010 individual tracts, involving a grand total of 1,907,608 acres, had been listed by this procedure and made available for agricultural use. These special areas may be considered "hand picked", and represent the cream of possible farm lands in the National Forests. During the fiscal year ending as above 2,336 individual areas were listed, involving a total of 238,525 acres. On a great many forests it is becoming apparent that the limit of land at all fitted for agriculture has been reached, and that there will soon be a falling off in the number of areas listed annually.

Reaching the limit of available land on many of the forests will have little present influence on the advance of agricultural development. This is due to the fact that upon many of the National Forests listing has been in excess of actual demand for settlement. The result has been that although the land has been listed it has not always been filed upon, and still less frequently has filing been followed by improvement and cultivation.

When the land has been listed but not filed upon there is some chance for real public service by bringing the land and real home-builders together. The records in each Supervisor's office are open to the public, and these records show what land has not been listed. Similarly, the records in the local land office are available and show, what land has not been filed upon. Inquiries addressed to Washington can not bring results for the reasons that filings may be made in the local land office at any time, and advice concerning available lands, which may be accurate today may be in error tomorrow. It is, therefore, almost a foregone conclusion that any land which is open to settlement will be secured by local people, if at all desirable.

Following the classification work thus done by the piecemeal examination of area applied for under the Forest Homestead Act, the Forest Service, in 1909, undertook a wholesale overhauling of the National Forest boundaries for the purpose of determining what areas had in the great haste of boundary examination been improperly included within the forest, and should therefore be eliminated, and also what areas were omitted which should properly be added. The work begun in the spring of 1909 is not yet completed, and probably will not be for several years to come. This is due, first, to the magnitude of the area requiring examination; second, to the manifold difficulties of the task; third, to the great care necessary to give all interests due consideration for the purpose of invariably taking uniform action under uniform conditions.

As a result of this boundary campaign the gross area of the National Forests, inclusive of Alaska, and not including the purchase areas in the Appalachians, was reduced by January 1, 1916, to a gross total of 156,446,486 acres, a total net reduction of 11,264,470 acres from the high tide total of April 30, 1910. This gross total, however, includes over twenty-one million acres of alienated land, the actual net area of National Forests of the United States, exclusive of Alaska and the Appalachian purchases of the East, being reduced at this time to 135,389,328 acres. As a matter of fact, the total area eliminated has been much greater than this figure, which represents the total decrease over and above two additions made by a

By courtesy of U. S. Forest Service.
Part of an area included in a National Forest for protective purposes, located on the northern border of Nevada. The cabin is a sheep herder's abandoned camping place.

special Act of Congress and a number of additional areas added by Presidential proclamation.

The work of the boundary examination, which is in reality one form of land classification, has undergone a very great change during the last three or four years. The Act of August 10, 1912, appropriating funds for the Department of Agriculture, carried for the first time, among its other provisions, a fund for the classification and segregation of land in the National Forests chiefly valuable for agricultural purposes. Successive appropriation Acts increased this fund until it is now uniformly one hundred thousand dollars a year. This money is being expended for the purpose of making available for farm use lands in the National Forests which are found to be suitable and chiefly valuable for that purpose. The work which was inaugurated under this Act is of a more permanent and final nature than the classification work carried on by the boundary and settlement examinations already described. Necessarily, boundary work can not deal with small interior areas. Examinations based upon the applications of individual land seekers must necessarily be widely scattered. But the work of classification under the special appropriation for that purpose has been thorough and systematic. Attention was given first to projects which are most likely to yield a considerable percentage of land suitable for farm purposes, but when a project was once begun, ordinarily it was continued until the entire area was covered, in order that there might be no necessity of going over the area again in the future.

The land classification work as now carried on within existing National Forests is conducted in two operations, one supplemental to the other. The preliminary stage is known as "extensive" classification work. In reality this is a classification reconnaissance. It covers in a broad way, usually by units of approximately a township in area, the lands which are very apparently not chiefly valuable for agriculture. While the so-called "extensive" classification work does not deal intimately with the various factors affecting each area in such a unit report, it does deal conclusively with the non-listable character of that land, for the reason that such reports do not attempt to pass upon the final classification of any areas which are at

all doubtful in character. If a given area appears to present any agricultural characteristics sufficient to warrant a home-seeker in giving it serious consideration for homestead purposes, it is left for the more detailed study and closer scrutiny, such as is given to all land classified by the "intensive" method.

Up to January 1, 1916, a total of about 56,000,000 acres of land within National Forests had been covered by such so-called "extensive" reports, and the classification had been approved by the Secretary of Agriculture. This work resulted in about 6,000,000 acres of land being eliminated from the National Forests. About 45,000,000 acres were classified as non-agricultural and non-listable under the Forest Homestead Act. The remaining 5,000,000 acres were patented lands, or lands otherwise alienated, and were therefore not affected by the classification or included in it. The reconnaissance classification has worked both ways. It has resulted in retaining within forests, under a specific non-listable classification, all areas most clearly chiefly valuable for that purpose. It has also brought out very clearly the location of the areas of doubtful forest value or possible agricultural value. When a forest has once been entirely covered by such reconnaissance or extensive classification, the areas of doubtful forest value or of probable agricultural value are all definitely and accurately determined. In a great many instances the result has been to clearly demonstrate that the only serious objection against retaining practically the entire area for National Forest purposes is the fact that certain errors have been made in running the boundary lines, whereby limited areas of land unsuited for forest purposes, or desirable for farm purposes, have been improperly included. In a number of instances such reconnaissance classification has been followed by boundary readjustments excluding the agricultural land and leaving only a few areas within the forest of possible value for homestead use. Such areas are then carefully examined and classified accordingly.

The classification problem, however, is not always so easily solved. In some instances, such as the Harney and Black Hills National Forests in South Dakota, it will be necessary to cover practically the entire forest with timber and soil survey, accurate in details down to each 2½ acre subdivision. Such work

By courtesy of U. S. Forest Service.

Head of Six Mile Canyon, Manti National Forest, central Utah, elevation 10,000 feet. This tract was included within a National Forest for protective purposes. The notable erosion shown by this picture is due in large part to unregulated grazing by sheep and cattle. A mountainous watershed in this condition is very liable to send destructive floods to the agricultural valley below.

is painstaking and expensive, but up to December 31, 1915, a total of 450,000 acres had been covered in South Dakota by this method.

Usually, however, reconnaissance examinations, and the boundary revisions which are based upon such examinations, have resulted in a permanent classification of over 90 per cent of the area in each National Forest. The classification has in many cases been governed by some one controlling factor. For example, it is not necessary to secure an accurate timber cruise of a township located at such an altitude that the weather reports show killing frosts every month in the year. Obviously, such land could not be used for farm purposes even if the stand of timber should be found to be very light. Again, it is unnecessary to consider questions of timber valuations when dealing with a tract of land having a topography utterly unfitted for farm purposes. By taking such facts into consideration it has been possible to carry on the work with great rapidity and at a low average cost. While some of the classification work done by the most intensive methods has cost as high as 10 cents an acre for the area covered, the average classification cost has been less than half a cent per acre.

The field work has already been finished on over one hundred million acres of National Forest land, but the mere mechanical labor of typewriting reports, and preparing and duplicating maps to cover such a vast area is in itself a stupendous task, and work now under way will not be put in final shape for official action before the close of another year. Meanwhile, however, the Forest Service, already has located very definitely practically all the areas of land of any considerable acreage having any material or prospective value for agricultural purposes, and by January 1, 1917, will have completed most of the reconnaissance classification surveys and will have accurate figures showing the total acreage remaining for final classification.

In the progress of this work the Forest Service has learned many things. The study of farm values in their relation to land in each National Forest and the investigations which have been made to determine the ultimate highest use of each tract of land in the existing National Forests, has brought out the

importance of taking into consideration the influence of local economic factors. The ancient expression that ''what is one man's meat is another man's poison'' has its truthful parallel in classification work in *what is one country's forest is another country's farm.*

In one locality where market conditions are unusually favorable as the result of a certain combination of conditions—as in the vicinity of Telluride, Colorado, where a large mining town is located at some distance from any important agricultural districts, and into which horse feed and dairy products can be shipped only upon payment of a heavy freight rate—aspen land at an altitude of 8,500 feet may be chiefly valuable for agriculture. Because of such unusual market conditons, which conditions appear to be as permanent as the mining camp itself, it may actually pay to clear such land of its timber and put it to such agricultural use. Even though the only crop it is practicable to raise is a crop of grain hay, the barrier of mountain gives such an advantage over outside produce that the price received offsets the disadvantages of soil, topography, and climate. And yet, less than 200 miles away exactly the same kind of land may be very valuable for its timber and for watershed protection and utterly valueless for farm purposes. Its location upon an important watershed, where water is of great value for irrigation purposes, and its nearness to a large agricultural region where great areas of alfalfa land are producing several crops a year, and where, in consequence, farm produce brings only an average price, while lumber, posts, and fencing are in great demand, so influences permanent values as to absolutely control the classification.

Because economic conditions differ as widely in the different States as topographical and other physical conditions, it has been found necessary to work out the problem in each region independently, taking into consideration the general factor of interdependence, which constitutes the economic sympathetic nervous system of the Nation. In the Black Hills region it is found that there is very little timber land suited for farm purposes or which, if cleared, would yield an agricultural return sufficient to justify the destruction of the forest, and that the local public understands this fact as clearly as it is understood

By courtesy of U. S. Forest Service.

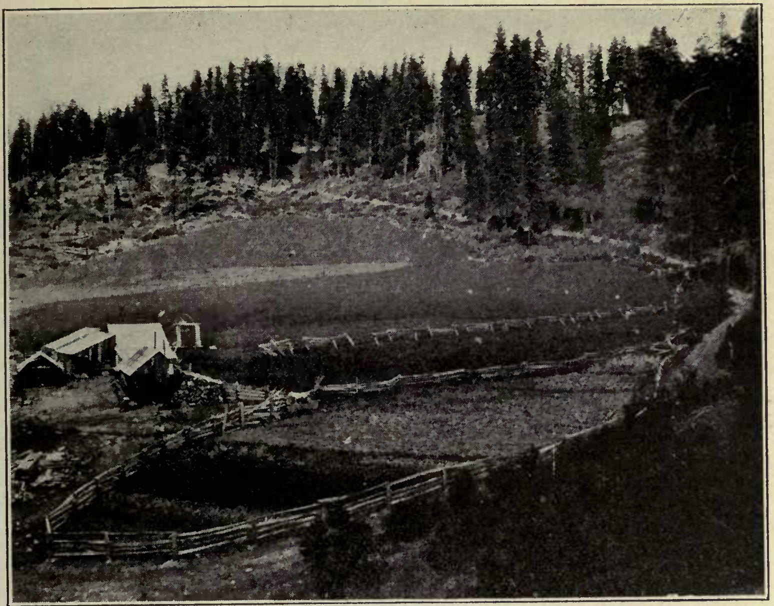
A site too rough to be used for agriculture included within a National Forest in Oregon. This tract was applied for as a homestead. The application was refused on the ground that lands of this character are too steep and rough for farming purposes.

by the Forest Service. On the other hand, in parts of Arizona and New Mexico, where there are vast areas of grazing land and but little hay land, the clearing of timber land even in a relatively non-timbered region may be good economics if water for irrigation is available and the hay produced on the area has a special value as a form of livestock insurance, being accumulated from year to year during the good years and kept to carry through the occasional bad winter a large herd of cattle that ordinarily run on the range satisfactorily the year long. But the timber land that may justify an agricultural classification under irrigation may be valuable only for its timber if water for irrigation is not available. In the first instance it may represent an annual production of 4 to 8 tons of alfalfa per acre, while on a dry farm basis it may represent an annual production of from half a ton to a ton of grain hay per acre, a return so scanty in comparison with the labor and expense of cultivation, seed, etc., that it is undertaken only where the crop has unusual value on account of its location and the land does not require any expensive preparation such as clearing.

In this way it has been necessary in every region to make a thorough study of the fundamentals of farm and forest economics peculiar to the region preliminary to the actual approval of any classification. Based upon such study, certain broad rules have been formulated as a general guide to be observed in that region. Perhaps the best known example of such a rule was the rule put into effect on certain lands along the Kootenai River in Montana, where under given conditions National Forest land was classified as chiefly valuable for agriculture and opened to settlement under the Forest Homestead Act if it did not carry a stand to exceed 4,000 feet B. M. of merchantable saw timber per acre. This rule was merely the concrete expression of the result of a very careful study of economic conditions in that particular region which showed such a relation existing between farm and forest values that in this given region land having certain characteristics of soil, climate, topography, and accessibility, would usually be developed for agricultural purposes if it had less than 4,000 feet B. M. of merchantable saw timber per acre, while if it had more than that amount the odds were in favor of it being held

for its timber value. This rule was given publicity out of all proportion to the region of its applicability, and it took some time to give equally widespread vogue to the fact that this rule applied only where all the physical and economic factors were the same as in the special region for which it was intended. Since then rules have been worked out for other regions; sometimes fixing the minimum of farm value which in a given region justifies cutting into a forest unit; sometimes naming the altitude in a given region above which, with a given slope and exposure, agricultural success cannot be expected; sometimes, for a given soil and precipitation, giving the maximum slope on which permanent agricultural success may reasonably be expected and beyond which the clearing of the slope will probably result in a gullied hillside of little value for either forest or farm. In short, all rules have been restricted in their application to a limited region within which the relation of the determining economic factors are found to be fairly constant. Yet, even with this restriction, it has been found necessary to provide for exceptions to take care of any special cases where some economic factor, because of some special condition, has changed the equation for a particular tract. Economic principles have been given precedence over all rules. In fact, each rule has been only the expression of the application of economic principles under certain fixed conditions. Therefore, whenever a rule is found to be inapplicable, the policy has been to fall back upon the original economic principle and be governed accordingly. In this way it has been possible to make rapid progress and to be both consistent and just.

The classification study and work of the Forest Service is constantly bringing out more and more clearly the importance of community influence as a factor in agricultural development. Probably no other economic factor has greater power in determining the future and highest use of land than the fact of the necessary relation of the land to the development of community life. Pioneering played such a large and necessary part in the development of our Nation that we have not always viewed it with the right perspective. The first settlements in every community have necessarily encountered pioneer conditions. Therefore, when a homesteader goes back into some re-



By courtesy of U. S. Forest Service.

A site which has been listed as agricultural land on the Boise National Forest, Idaho. Not a very extensive farm, but the owners want it and seem to be able to make a living. Altitude 8,000 feet. The snowfall covers the fences here in winter.

By courtesy U. S. Forest Service.

This land is heavily timbered, but is a level tract along the river bottom and suitable for agriculture. It has been listed as agricultural land and is located in central Idaho, Boise National Forest.

mote gulch where he has found perhaps 100 acres that could be farmed if cleared of its timber, he has been inclined to think that, although the place may be ten miles from the nearest house, he is no worse off in that respect than his father or grandfather was when he settled on river bottom land along the Missouri. He overlooks the fact that his father's or grandfather's place was surrounded by equally suitable farm land extending for miles in practically every direction, so that the isolation of pioneer life was only an incident of his younger manhood, and that settlement followed rapidly, resulting in community development and the establishment of the community institutions which are usually incident to civilized life, such as roads, schools, churches, physicians, newspapers, mercantile establishments, etc. Such community development cannot follow the settler into the hills, because no power can push back the mountains no matter how desirable it may be to replace them with farms. Consequently the landseeker is at last beginning to realize that in anticipating pioneer conditions the most important consideration is whether those conditions are probably only transitory or whether topography makes them permanent. A full realization of the importance of community institutions and their influence on farm values has resulted in very much liberalizing the application of classification principles as applied to land adjacent to or intermingled with established growing rural communities. It is realized that such land may be very desirable for individual use in connection with established farms, although land exactly similar in character, situated at a distance from farm development, and not intermingled with more valuable farming land, may be practically valueless for farm use. The proper appreciation of the importance of community influence has, in consequence, resulted in the elimination of many small areas of National Forest land having relatively low value for either farm or forest purposes, but so located that their logical highest use was use under private ownership in connection with other farming activities. Conversely, it has resulted in retaining for forest purposes small patches of land topographically suited for farm purposes, but so located as to be of no real economic value for that purpose on account of permanent isolation, while at the same

time of real value for forest purposes on account of the interdependence of other parts of a large and important forest unit.

The question arises, when will this work of National Forest land classification be completed? The answer is hard to give. The total area will be covered in a very few years, but there will be occasional re-examinations to make from time to time. Even in older countries, where forestry and agriculture have been established for centuries, the work is still going on. In some places one-time farm land is being planted to forests, while parts of the forests are being cleared for farms, these changes representing the results of experience and not the vagaries of a shifting policy. So may we also expect to do in the future.

The sophomore forestry students of Iowa State College, accompanied by three members of the faculty, will make a 4000-mile trip this summer to study at first hand lumbering methods, reforestation, marketing, fire protection, and other forestry operations. A camp lasting three weeks will be established on the St. Joe National Forest, Idaho, and four weeks will be spent on the Columbia National Forest, Washington. Other National Forests to be visited are the Pike and Holy Cross in Colorado, Uinta, Utah, Plumus and Shasta in California, Snoqualine in Washington, Lolo and Deerlodge in Montana, and the Nebraska National Forest. An intensive timber reconnaissance of several townships will occupy the main part of the work in one of the camps. The class will leave for the West on June 2 and will return approximately September 10.

Iowa State College has the largest and oldest extension department in the middle west. The addition of a forestry expert and landscape architect last fall is a step in advance in the development of Iowa homesteads. Mr. R. J. Pearse devotes his entire time to the planning and planting of farmsteads, school grounds and the development of other public and private properties. The great aim is to stimulate interest for good forestry and landscape work in all parts of the state.

Possible Remedies for Monopolistic Conditions in the Lumber Industry

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In a previous issue of the Forester the writer traced the early history of the United States forestry policy. In a monograph which is now in the publisher's hands the history of that forest policy has been brought down to the present time, and the results have been analyzed in detail. In that monograph the writer has indicated how as a result of the unwise policy pursued by Congress most of the timberlands of the country have gravitated into the hands of a few holders, and how, upon the basis of this concentration in the ownership of the standing timber, there have developed certain monopolistic conditions in the lumber manufacturing industry. It is the purpose of the present article to consider the various ways of dealing with this so-called "lumber trust".

Before proceeding with the question of remedies for the situation which faces us, it will be wise to note briefly just what the situation is, first, in regard to the ownership of standing timber, and second, in regard to the lumber manufacturing industry.

The privately owned standing timber of the United States, according to the best estimates, amounts to some 2,197 billion feet, worth at least $6,000,000,000. Of this total amount about four-fifths were included in the area investigated by the Commissioner of Corporations; and of the amount in the investigation area nearly half was owned by holders of one billion feet or over; 32.2 per cent by holders of 3½ billion feet or over; 26 per cent by holders of 5 billion feet or over; and 19 per cent, nearly one-fifth, by holders of 13 billion feet or over. Over 69 per cent of the unreserved timber in the investigation area is owned by holders of 60,000,000 feet or over.

To illustrate the magnitude of some of these figures, it may

be stated that a billion feet of lumber would load a freight train 417 miles long, or would build about 65,000 ordinary five or six-room houses.

Concentration of ownership in terms of board feet is sufficiently startling, but perhaps nearly as significant are the figures in terms of acreage. The three largest timber holdings in the United States, those of the Southern Pacific, the Weyerhaeuser Timber Company and the Northern Pacific, aggregate about 9,000,000 acres of timberland, some of it among the finest in the world. The five largest holdings in the country include 12,794,000 acres, an average of 2,560,000 acres each. Among holdings smaller than these are 9 of from 500,000 to 1,500,000 acres, averaging almost 1,000,000 acres each; 27 holdings of from 300,000 to 500,000 acres each; 48 holdings of from 150,000 to 300,000 acres; 124 of from 75,000 to 150,000 acres; and 520 holdings of between 18,000 and 75,000 acres. Thus 733 holders own in fee a total of 71,521,000 acres of timberland and land owned in connection with or in the vicinity of this timberland, an average of nearly 100,000 acres each. Nor is this all. There are 961 smaller holders owning a total of 6,731,000 acres, an average for each of 7,000 acres, the equivalent of 40 homesteads. This makes a total of over 78,000,000 acres owned in fee by 1,694 holders, over one-twentieth of the land area of the United States, from the Canadian to the Mexican border.

Several factors make the power of these large timber holders really much greater than any figures as to acreage or lumber feet would indicate. In the first place, large timber holdings are proportionately more valuable than small holdings, even when the timber is of only equal quality, because large holdings can be so much more economically managed in every way. In the second place, the large holdings in many places have the smaller holdings "blocked in" in such a way as to practically control them. In the third place, the large timber holdings everywhere include the most valuable timber,—the heaviest stands and the most valuable species. In the fourth place, many of the various large holders are bound together by various interrelations of interests in such a way as to make possible common policies. Furthermore many of the large tim-

ber owners are not cutting their timber, but are holding their estates intact and perhaps buying up smaller tracts for immediate cutting. Finally, it is of course evident that with the rise in timber values the power of the holders of the remaining supply will be greatly augmented.

Now upon the basis of this concentration in the ownership of standing timber, a monopolistic situation has developed in the manufacturing industry. Associations of manufacturers have been formed and have grown strong enough to manipulate prices to their own profit, sometimes by concerted curtailment of output, sometimes by adherence to a price list, sometimes by other means.

The evidence presented in the Missouri Ouster Suit and likewise much other evidence that is available, indicates clearly that the lumber manufacturers are strongly organized and that they have often raised prices by illegal concerted efforts.

The question now arises as to what remedy is proposed for such a situation as has been here briefly outlined.[1] Four different methods of attack might be suggested. First, the Government may attack all unlawful combinations among lumbermen or lumber dealers under the anti-trust laws, Federal and State, and in that way try to secure competitive prices for consumers. In the second place, the Government might recognize the lumber business as a natural monopoly based on the possession of a natural resource, and regulate prices through a commission. In the third place, since monopolistic conditions in the manufacture and distribution of lumber are in general based upon a monopoly of the standing timber, the Government might perhaps strike at the root of the problem by imposing a graduated tax on timber holdings and in that way break up the large estates. In the fourth place the Government may simply extend the system of National Forests as rapidly

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[1]For excellent recent discussions of the trust problem, see articles by Prof. E. Dana Durand in the Quarterly Journal of Economics for May and August, 1914; and by Prof. W. H. S. Stevens in the Political Science Quarterly for June and September, 1914. Among other works on the same subject are: (1) John Bates Clark, The Control of Trusts; (2) Richard T. Ely, Monopolies and Trusts; (3) Charles R. Van Hise, Concentration and Control; (4) Bruce Wyman, Control of the Market; and a great number of other contributions of importance. The amount of trust literature is altogether too great to be given consideration here.

as possible, and thus try to secure a large enough proportion of the timberland so that it can set prices for the public.

The "trust-busting" policy was naturally the first one to be tried in this country, and since about 1906 the Federal Government and some of the state governments have been very active in their efforts to break up lumber combinations. In considering this government activity two questions arose: first, is it desirable to break up such combinations; and second, is it possible to do so.

The problem of breaking up combinations in the lumber industry brings with it the whole question as to the advantages or economics of large-scale organization. It is impossible to go into a minute analysis of this question here, but it will be pertinent to suggest that many of the advantages claimed for large-scale organization in general are not of great importance in the manufacturing of lumber, because the most efficient unit in the business is comparatively small. "To enlarge a mill beyond a capacity of 20 or 25 million feet a year is to duplicate mechanical units, with small or doubtful advantage in manufacture, and with certain disadvantage in the cost of transporting logs. It is a matter of dispute among lumbermen whether a mill of 20 million feet capacity, under the usual conditions of transportation in the southern pine territory, is not more economical than a larger one."[2]

There is without a doubt considerable economy in the so-called "integration of industry," that is, in the union of various successive related processes under the same management. In certain regions it may frequently be in the interest of efficiency and economy that a single organization should control the standing timber, own and operate all the logging equipment, the saw-mill and perhaps even wholesale and retail establishments. It is almost everywhere desirable that mill owners should own their own standing timber because in this way they can eliminate much of the element of uncertainty in the securing of timber supplies, and so insure the most economical use of milling capital. The contests between the loggers and the mill men on the Pacific coast, often resulting in very severe losses to those concerned, indicate that logging and mill-

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[2]Report of the Commissioner of Corporations on the Lumber Industry, I, 35, 36.

ing should if possible be carried on by the same organization. Now while the most efficient sawmall is not a very large unit in itself, if with it are included the various other items which may be effectively combined, a rather large initial investment is indicated,—in some regions an investment of millions of dollars. The purchase of several thousand acres of valuable timberland,—enough to guarantee a timber supply for the reasonable life of an efficient mill, in itself involves a very heavy outlay; and in some regions, as for instance in the cypress fields, logging equipment represents a large expense. The cost of drying kilns, the capital tied up in drying woods, and the advances to loggers and mill hands amount to considerable sums.

It may be stated at this point, however, that it has not been the policy of the Government to attack such integrated organizations as have been suggested. The Government has made no objection to the combination of timber ownership, lumber manufacturing and all other processes under one management, but has merely tried to prevent the combination of a number of these large units into one association for the purpose of manipulating prices. It is clear that this latter sort of combination, the combination of similar units performing similar functions, the so-called "horizontal" combination, is an entirely different proposition. It not only represents vastly more power, but it certainly does not effect the same economies.

Some economies there may easily be, however, even in this latter type of combination. Doubtless it may secure cheaper distribution of the product, through a reduction in advertising and selling expenses, and a saving in cross freights. Perhaps it may prevent some needless duplication of plants,—an important consideration in the lumber industry where there is always a considerable amount of capital tied up in useless milling and logging equipment. It might even permit some specialization among the various mills, although this is not certain. Experience has already shown that combination can do much in adjusting the supply of lumber to the demand, thus securing more stable conditions in the industry. This is a consideration of great importance because of the fact that the lumber industry is peculiarly sensitive to changes in the general

business situation. Whether combination among lumber operators would result in the adoption of more efficient accounting methods or better machinery is perhaps not quite certain, but there might be some gain here.

There is thus something to be said for the economies of combination even in the lumber business. It should of course be noted that while the lumber industry presents examples of a great many different kinds of combination, most of the lumber associations are not closely knit organizations, many of them not strong enough to secure all of the advantages possible to effective combination.

Even if we admit the desirability of breaking up these combinations, there still remains the question as to the possibility of doing it. As indicated in the preceding chapter monopolistic combinations have existed in most fields of the lumber industry, often strong enough to raise prices materially; and in spite of the activity of Federal and State prosecuting agents, many of these combinations still exist. Most of them have altered their form of organization or their scheme of operations; others have been weakened; but many are still strong enough to manipulate prices to their own profit, and, from evidence at hand, are doing it. The Government has certainly not been entirely successful in its policy of breaking up lumber combinations, and there is no reason to believe that it will be in the immediate furture.

Some success, however, has certainly been achieved. No student of the recent history of the lumber business can fail to concede that the vigilance of the Federal and State governments has broken up some of the worst forms of monopoly activity; has driven some illegal combinations to cover; and, perhaps more impotent than all, has to some extent prevented the formation of others. Monopolistic activities have been, to say the least, more difficult since 1906; and some that were possible before that date, have been impossible since. It is doubtful whether the lumber industry as a whole is as strongly organized now (1915), as it was ten years ago. The decision in the Missouri ouster suit for instance, was a crushing blow to the yellow pine ring; and the provisions of the verdict rendered

would seem to promise something for the effectiveness of Government control.

To what extent the attitude of the Government has prevented the formation of new lumber combinations, it is of course difficult to judge intelligently. It is perhaps significant, however, that nearly all of the powerful lumber associations had their inception before the time of Government anti-trust activity, which dates from about 1906. The National Lumber Manufacturers' Association was organized in 1902. The Missouri and Arkansas Lumber Association, perhaps the earliest of the yellow pine associations, dates from 1883; and the Southern Lumber Association, later to become the Yellow Pine Manufacturers' Association, was organized in 1890. The Georgia Saw Mill Association, the predecessor of the Georgia-Florida Saw Mill Association, was formed in 1899. The first organization in the field of North Carolina pine dates from 1888, and the present North Carolina Pine Association was formed in 1905, by the union of the old North Carolina Pine Association and the South Carolina Pine Association, both of which had been organized some years previously.

In the Douglas fir territory as elsewhere, lumbermen's organizations run back to the period previous to 1906. The loggers of Puget Sound organized the Puget Sound Timbermen's Association as early as 1899, and this organization has persisted under various names. The Washington Logging and Brokerage Company, since 1907 known as the Washington Log Brokerage Company, was formed in 1904. The three associations among the mill men of this region; the Southwestern Washington Lumber Manufacturers' Association, the Pacific Coast Lumber Manufacturers' Association and the Oregon and Washington Lumber Manufacturers' Association, were organized in 1900 and 1901. The combination of these three into the West Coast Lumber Manufacturers' Association was, however, not effected until 1911; and some subsidiary price regulating organizations in this region have also been formed in very recent years.

In other fields of the lumber industry, as in those mentioned, most of the present lumber combinations were formed previous to 1906, although some consolidations and reorganizations have been effected more recently. In this connection it must

be pointed out that most fields of the lumber business were fairly well organized before the Government began its anti-monopoly campaign, and that therefore there has been no great occasion for the formation of new organizations since; nevertheless, bearing all the evidence in mind, we can scarcely escape the conclusion that the number of such monopolistic organizations is now less than it would have been but for the hostile attitude of the Government. The abandonment of the proposed North Carolina Pine merger is a case in point.

Finally then, as to the effectiveness of Government efforts to break up lumber combinations, the most definite conclusion that the information at hand will justify, is that, while the lumber industry is still strongly organized, part of it perhaps entirely beyond the reach of anti-trust prosecution, nevertheless the Government has accomplished something, has even achieved some notable success. Some students of the question may feel that with further experience, with improvement in the anti-trust laws and in the machinery for their enforcement, with the elimination of various unfair practices, with increasing publicity of corporate affairs, and with the development of supplementary legislation, such as for instance, Federal incorporation laws, the Government will be able to handle the lumber situation successfully, without departing from its present policy. Other students of the question will view the situation more pessimistically, will feel that it is impossible to break up combinations in this way, that as fast as the Government devises new methods of attack, the lumber organizations will invent new means of evasion, and that in the end, the Government will be driven to direct regulation of prices.

The possible advantages of combination in the lumber industry have been indicated above, and certainly they must be given due consideration. Whether these advantages are so great, however, and whether their preservation is a matter of much importance as to justify the Government in abandoning its present policy, to embark upon a wholly untried scheme of price regulation, is quite another question.

The idea of price regulation by means of a commission seems attractive in many ways.[3] It has a directness, a finality, an

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[3]Van Hise, Concentration and Control, 238-242.

apparent simplicity even, which presents a strong appeal to certain minds. It is perfectly conceivable too that if the Government is to engage in the regulation of prices at all, lumber prices might seem as good a point of attack as any. The industry is based on a natural monopoly, is fairly well centralized, the product simple and generally well standardized. Furthermore the cost of production, as far as that might enter into the fixing of price, could be as easily determined for lumber as for almost any product.

It will be profitable, however, to point out certain objections to this scheme, to indicate briefly some of the difficulties involved. Immediately questions arise as to the personnel and manner of appointing such a commission, and the scope of its powers. To be effective, it must, of course, have broad powers, and this would make its personnel a matter of the greatest importance. Clearly if the lumber interests were to have a strong representation on the commission its work might amount to little or nothing. It is scarcely to be doubted that any representatives of other lines of business on this commission would line up with the lumber representatives in most events, because once the Government embarked on a policy of price regulation, most lines of big business would cooperate in common self-defense. Experience with minimum wage commissions points to the possibility of difficulties of this nature.

It would perhaps be fairly easy to conceive of an ideal commission, with a majority of highly trained men who could handle the business with intelligence, but it is easier to conceive of a commission created accordng to canons of political expediency, the fruit of political debates and trades and compromises rather than of intelligent and judicious planning. Experience with the Interstate Commerce Commission indicates that it would take many years of experimenting to develop any degree of efficiency in the regulation of prices.

The price regulating commission would presumably be a Federal institution, and the definition of its powers and jurisdiction would present certain difficulties. It could get jurisdiction only under the interstate commerce clause of the constitution, and so would be unable to reach lumber which did not enter into interstate commerce, unless effective cooperation were se-

cured with state commissions of similar nature. The difficulty of securing such cooperation with some of the states, and the tangle that would result from a failure to secure it can easily be understood. Some states might feel that Federal prices were too high; others, where lumber interests were strong, might feel that they were too low. A situation might even conceivably arise in which consumers in a lumber producing state would have to pay a high price, fixed by the organized lumbermen of the state, or by a commission under their influence, while consumers across the state line were getting the same lumber at a low price, fixed by the Federal commission. A host of unforseen complications would certainly arise in connection with the mere question of jurisdiction. Of course amendment of the constitution of the United States would clear away some of these difficulties, but amendment could be secured only after a long and energetic campaign, if at all; and even if it were accomplished, state constitutions might still interpose obstacles to effective price regulation.

The most serious difficulties connected with the whole scheme would of course enter with the matter of price determination; and the first question would be as to the basis upon which prices should be determined. A vast number of items would clearly have to be considered: cost of labor; logging and milling equipment, original cost, interest charge and depreciation; more remote items, such as fire protection and taxes, (in the first instance these would have to be reckoned for years previous); and perhaps more important than all, the value of the standing timber.

A very careful system of cost accounting would be needed here, and it is probable that the Government would have to prescribe a uniform system for all lumber manufacturers. Many of the mills have had no effective system in the past, and it might be many years before the Commission would have enough comparative data to proceed with intelligence.

The value of the standing timber would have to be considered. In most cases a price has been paid for it, and to fix a uniform price schedule without considering this price at all would be confiscation; whether the manufacturers themselves own the timber or whether they buy from timber owners. This

is not to assume that the original price, or even any subsequent price paid, is an accurate index to the value of the timber, for it may have no significance whatever. For instance the $6.00 per acre paid in the great Weyerhaeuser purchase of 1900 has no significance as to the present value of the land. In order to get any idea of present values it might be necessary to institute an extensive and thorough cruise of all the timberlands in the country.

Unfortunately, however, it appears at this point that the whole idea of considering present values in the fixing of a price schedule involves a logical absurdity, a "vicious circle" in reasoning. How can any price be fixed on the basis of the present value of standing timber, when the value of the standing timber is directly determined by the price fixed? The value of standing timber depends upon the price at which it is anticipated, the lumber can finally be sold; and how can it serve as the basis for determining the price at which it is to be sold? How can timber values and lumber prices each be in turn cause and effect?

In the case of joint products special complications would arise. For instance the yellow pine forests of the South produce turpentine and lumber. Hemlock is valuable for its bark as well as for its wood. How shall the price of the lumber be determined with relation to the other products? Some mills produce different kinds of products, lumber of many kinds and grades, shingles or lath, and perhaps excelsior. How much of the fixed charges and how much of the operating expenses shall be attributed to each product?

It might sometimes be difficult to adjust the price of different kinds of woods so as to do justice to each section of the country. As long as there is competition between different sections of the country this matter is regulated, but if once this competition were eliminated it might be very difficult to find a satisfactory basis for the determination of relative values in the various markets of the country.

Under the present regime, to a considerable extent competitive, most lumber prices tend to fluctuate greatly, because of the fact that the demand for lumber is extremely variable, while the supply responds only tardily. Now it is clear that

no commission would be able to change the price schedule with any degree of facility; and the establishment of fixed prices would bring in unprecedented conditions which can scarcely be more than guessed at. In times of business activity excessively large amounts of lumber would be demanded, because there would be no rise in prices to discourage its use; in times of depression very little would be called for because there would be no lowering of prices to stimulate demand. How could the supply be adjusted to such a widely varying demand? Even under present conditions, there is a great waste in the industry, because so much capital is idle during slack seasons, and it seems that this waste would be much greater under the circumstances suggested.

It might be suggested that the commission could vary prices according to changing industrial conditions, but even if this were possible, it is very doubtful if it would be a wise policy because of the uncertainty and uneasiness it would bring into the situation. It seems that prices fixed by the commission would tend to remain the same for considerable periods, perhaps even for years, somewhat like the rates fixed by the Interstate Commerce Commission.

Lumber prices will certainly show a strong upward tendency for a long time, and as prices gradually rise consumption will decline and waste will be reduced. The higher prices will have a conserving tendency. It is interesting to speculate as to what would happen if a Government commission were regulating prices. As stated above, there would be a strong tendency for such a commission to fix a certain level of prices and adhere to it, perhaps for years. The changing relations of supply and demand would present no just ground for altering the schedule unless there were also increasing costs of some kind. Now with the growth in the population of the country the demand for timber will certainly increase; and if prices were to remain about the same, might not our timber supply be very speedily exhausted? Would there be any incentive for timber owners to preserve their timber for the future? Certainly the expectation of a future rise in stumpage values is the chief reason why many timber owners are not clearing their land now; and if this hope of future profit were taken away, if holders

felt that prices would remain the same for a long period, they would cut their timber as fast as the market would absorb the product, unless the Government also in some way taxed or regulated the output.

If the commission were to follow a policy of permitting lumbermen to raise prices merely because the supply of timber was decreasing, when there was no increase in the cost of production, it seems that it would to some extent fail in its avowed purpose, which is to protect consumers from unreasonably high prices.

Advocates of Government regulation of prices sometimes point to the experience of the Interstate Commerce Commission as an example of success in Government regulation. Without entering into any discussion of the Interstate Commerce Commission and its work, it may be said that it is not very significant as to the desirability or feasibility of regulating general commodity prices. In the first place it was absolutely necessary that interstate commerce rates be regulated; and this cannot be said of lumber prices. In the second place, perhaps it cannot be said that the Interstate Commerce Commission has been so successful in its work up to the present date as to throw a particularly favorable light upon the general policy of Government regulation. The commission has been mainly interested in preventing unjust discrimination between persons, localities or kinds of freight, and has done very little, if anything, in the fixing of specific schedules. The general rate structure for the country as a whole has been determined almost entirely by the railroads themselves. There is little probability that the commission itself could ever have made out entire rate schedules for the roailroads, and applied them successfully. The work now done by the Interstate Commerce Commission is very different in many ways from that which would be required of a commission for the regulation of lumber prices.

It might of course be argued that the lumber commission could follow out a policy similar to that of the Interstate Commerce Commission, simply adopt the present price schedules of the lumber companies and permit no advances except upon proof that such advances were reasonable. Since lumber

prices will for a long time tend to rise, the commission might thus reduce its work to merely "sitting tight", allowing few advances, and meantime regulating such matters as unjust discrimination and unfair practices.

It seems probable that the price regulating commission would adopt a policy somewhat similar to this; and possibly it would prove successful. It may be well to point out, however, that many of the difficulties urged above to the general scheme of price regulation would be encountered in this procedure as well. The questions of personnel, manner of appointment, and jurisdiction would not be simplified. A careful accounting system would be needed, although perhaps it would not be so important as if price schedules were to be fixed immediately by the commission.

The questions regarding joint products and the relation of prices of different woods might be largely solved by the lumber companies themselves without much interference from the commission. The problem of adjusting supply to demand would not be simplified; low prices would in any case stimulate forest destruction; and if the value of standing timber were to be reckoned in the determination of prices, it would involve the same circle of reasoning that was pointed out above.

One objection which is sometimes urged against price regulation in general, is that it leads to Government ownership and socialism; but this objection has very little force when applied to the lumber industry, for Government ownership is the ideal toward which we should be working.

Perhaps it may seem that since monopoly conditions in the manufacture and distribution of lumber are dependent on ownership of the standing timber, the logical procedure would be to attack the question there, to break up in some way the monopolistic control of standing timber, break up the large holdings.[4]

There are several reasons why the present situation in regard to the ownership of standing timber would seem to demand some kind of a remedy; some reasons why, as a matter of equity

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[4]See E. Dana Durand, The Trust Problem, in the Quarterly Journal of Economics; August, 1914, 672-674.

and justice if nothing more, the large holders might be shorn of some of their power. In the first place we must recognize that no labor is required to discover standing timber, as contrasted with such natural resources as iron ore, coal, or petroleum. The search for minerals is a real public service; but timber is conspicuous upon the surface, and could never fail of being turned to account for lack of knowledge of its existence.

Not only have timber owners as a class rendered no particular service in ''finding'' and appropriating timber lands, but many of them have given no equivalent in any other way for the valuable resource they now hold; many of them have merely stolen their lands. As indicated in previous chapters, many of the railway grants were not really earned; the two great timber owning railroads, the Northern Pacific and the Southern Pacific, presenting notable examples of bad faith in their disposition of their grants. Various other railroads furnish examples quite as bad on a smaller scale. Swamp lands were often, perhaps usually, acquired fraudulently, and the terms of such grants were not often complied with. Most timber lands acquired under the Timber and Stone Act, the Commutation Homestead Act, the Preemption Act, and the Desert Land Act, were acquired fraudulently; indeed there was about one general public land law under which large holdings could be honestly taken up, and that was the Cash Sale Law, and even under that law the payment for the lands was of course grossly inadequate.

Since so much of the timberland was stolen in the first place, there might seem to be special reason why a few holders should not own it all, special reason why the Government might try to regain control over more of this resource, or might try to secure a more equal division, perhaps break up some of the large estates in some way. In judging of the wisdom of any such plan of procedure it will of course be proper to consider that a vested wrong may in time become a vested right; that much of this land is not now in the hands of the original holders; that some of it is now owned by holders who have paid full value; and that the proportion of such holders will grow from year to year as more of this land changes hands.

If we were to go so far as to advocate breaking up of some of these great timber estates in some way, the most obvious method would of course be taxation, perhaps a progressive tax, somewhat after the Australian or New Zealand plan, imposing an especially heavy burden on the very large holdings. It might be argued that this would tend to encourage the division of these holdings into moderate sized tracts; or that even if it did not have any decided tendency that way, it would at any rate be equitable as a system of taxation, apportioning burdens according to ability, since the real wealth, power, or ''ability'' of these large holders is more than proportionate to the size of their holdings. If furthermore, it saddled a special burden upon a class of large-scale land thieves, so much the better.

It is not the purpose of this chapter to enter into an exhaustive discussion of the progressive tax, or of the general question of remedies for our timber situation; but it will be worth while to consider briefly a few very weighty objections to any scheme of breaking up the large holdings by means of a graduated tax on timberlands.

In the first place, aside from all questions of constitutionality or conflict of jurisdictions, such a scheme may seem unfair to some holders, for some who have purchased a recent years, have paid full value for their land.

In the second place, any tax graduated sufficiently to be effective would promote a rapid forest destruction which is exactly what conservationists should wish to avoid. It has everywhere been observed that heavy taxation of forest land results in premature cutting of the timber.

The decisive argument against the taxation scheme suggested is, however, that it is not desirable to break up these large holdings. The Australian and New Zealand taxes apply to agricultural land, and are probably justified by social considerations.[5] It is not desirable to have agricultural lands in large states; but the situation in regard to forest land is quite different. A large holding of timber land is proportionately easier to protect from fire and from trespass, and is more economically managed in every way. The cost of fire protection is a very important item in the timber business, and for the

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[5]Seligman, Essays in Taxation. Eighth edition, 459-466, 516-522.

large holdings this cost is proportionately much lower than for the small holdings and protective measures are far more effective; indeed it is almost impossible to afford adequate protection to a number of scattered small lots. The holder of any such lot is very much at the mercy of his neighbors, any one of whom may by carelessness jeopardize all the timber in the community. The breaking up of timberlands into small holdings would thus increase the cost and decrease the effectiveness of fire protection and of management in almost every way.

Perhaps the best thing that could be said for a progressive tax is that it would not really be effective because it would be evaded. Many large holders would doubtless pretend to break up their holdings, but would retain control through gentlemen's agreements and through various other subterfuges so common in the general field of monopoly. If in this way the tax could be rendered ineffective it would perhaps do little harm, but of course it would then yield no revenue and would have no excuse for existence.

No doubt some scheme of taxing the annual cut would be better than a tax on the land, and tax legislation is turning to this more and more in recent years. It is difficult, however, to see how this tax could be graduated in such a way as to break up large estates. It might of course be graduated so as to bear heavier upon those establishments having the larger output, or it might be imposed only on the larger organizations, (those larger than the unit of maximum efficiency); but it is not easy to see how this would improve upon the policy of breaking up trusts, except that it would tend better to conserve the timber supply.

The reasons why forests should be owned by the Government have been discussed in various connections, in fact, the wisdom, perhaps we may even say the necessity of Government ownership, is the great outstanding lesson to be gained from the study of the United States forest policy as outlined in the preceding chapters. Almost all the advanced countries of the world have found it necessary to take over the management of their forests; and the United States must eventually enlarge her field of activities along this line.

Our National Forests will of course play a more important

part in the future than they do now. At the present time they are of course much less important than their area would indicate, because only part of the land is timbered, and the timber included is of poor quality and inaccessible. The Forest Service is handling the timber very conservatively, however, cutting less than the annual growth, so that the amount of Government timber is even increasing; while the privately owned timber is being cut at a very rapid rate. Furthermore the Government is slowly taking over tracts of denuded land under the Weeks Law, and is again planting it with trees. Thus the relative importance of the publicly owned timber is bound to increase greatly in the future, and this will tend to prevent the large private holders from too gross abuse of their power.

In conclusion then, it appears that of the several remedies suggested for our lumber and timber situation, the only one worthy of unqualified approval is the last,—the extension of Government ownership and control. The scheme of breaking up large timber holdings by means of a progressive tax has been as unqualifiedly rejected. In regard to the two other remedies considered, it has seemed wise to take no stand, but merely to point out the various advantages and disadvantages that might be claimed for each plan of procedure. It is hoped that this caution and conservatism will not lay the writer open to crimticism on the ground of having avoided or glossed over vital issues. Much has been written about trusts and monopolies in general, about the Standard Oil Company and the United States Steel Corporation, and various other monopolistic combinations; but comparatively little is generally known about the lumber industry. The report of the Commissioner of Corporations contains a vast amount of valuable information; but this report is about the only ready source of information, it has been given little general publicity, and it is not at all concerned with the question of remedies.

Thus the writer is exploring new fields, and abundant caution would seem to be fully justified. If the above suggestions as to remedies have any effect in arousing interest in the matter, in stimulating others to follow up with fuller knowledge and more careful analysis, their inclusion here will perhaps be justified.

University Extension Work in Forestry

SHIRLEY W. ALLEN, '09
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The wag who said he had no use for forestry because "Posterity has never done anything for me" was fairly well informed and very honest. The man who waxed warm on the wastefulness of the lumberman and the timeliness of forestry and then pastured his woods and kept them full of dead and down timber was also well informed but not so honest. The County Fair visitor who asked the man in the forestry booth whether he was an organizer for the Ancient Order of Foresters or a Tree Surgery expert was honest enough but in sore need of information. These men represent very well the attitude of the average citizen who has any idea of forestry at all. They also stand as an eloquent indication of the great opportunity in educational work for the general public along forestry lines.

This kind of educational work as in the case of any economic question can best be accomplished by what has come to be known as University Extension Work. The latter is defined in the New Standard Dictionary as "A system for extending the advantages of University instruction beyond the limit of Universities, by the establishment of lecture courses and classes in or near populous centers."

I think I am safe in saying that New York State through her College of Forestry at Syracuse University is a pioneer in this Extension work in Forestry. As early as 1912 lecturers from the Faculty of the College were sent out over the State to talk before Granges, Men's Clubs, High Schools and other organizations. Since that time the work has been prosecuted with great vigor until at present it is organized as a definite Department in the College. Four men are kept busy with lectures, demonstrations and the various other lines of work now falling properly under University Extension.

The visiting of over two hundred communities in one sea-

son and the giving of as many illustrated lectures is only a part of the extension activities. The worker who visits a high school is always ready for a field excursion with the biology classes or with some of the older pupils. The man who goes into a county to help the local farm bureau or a number of granges expects to conduct a demonstration for some neighborhood in timber estimating, marking, planting or timber treating. The forester in charge of an exhibit at the state fair or county fair must be prepared to answer questions ranging from "How do you control the elm leaf miner?" to "How expensive may my land be to guarantee a fair return from planting red pine?" In the office a forester in this department may find himself called upon to outline a season's reading course with suggestive questions for a Woman's Club, to get out material for a high school debate on some angle of the forestry question, to get up an exhibit for an agricultural high school or to write a magazine article or a press bulletin on some producing or marketing phase of the business.

Some of the more interesting extension activities outside of lecture work are the maintenance of a wood utilization service whereby the users of timber and mill waste are brought into communication with the producers by means of a monthly bulletin made up from inquiries sent in to the College; the supervision on Arbor Day of the planting of a thousand or more trees by various high schools on city watersheds or pieces of waste land secured for the purpose of a school forest, the placing of a wood collection of some 30 hand specimens of commercial species, in the schools of the state, the management of a few small libraries of forestry books and bulletins gotten together for lending to schools and public libraries throughout the state, and the conducting of a correspondence course in "Lumber and Its Uses."

A certain amount of help along the line of improvement of shade tree conditions and so-called "City Forestry" has been demanded of the college and one man gives all of his time to extension work in this line. A good many cities and villages have been stirred to action by means of a survey of shade tree conditions, a tree census by the school children and a public

meeting. Notable among these is the city of Mt. Vernon, where the college gave valuble aid in the drafting of a shade tree commission calling for the permanent services of a trained man.

The question of financing the extension work in Forestry is taken care of through a direct appropriation from the state for this purpose. The college agrees to send its men into any given neighborhood for a week of lectures (three communities or more) without cost to the requesting agency, and requires only that a crowd of more than 50 people be guaranteed and that consistent local effort be put forth to advertise the meetings. Where a forester goes out for only one lecture or demonstration, the requesting agency is required to pay his traveling and subsistence expences. The appropriation also takes care of the other activities except that libraries which borrow sets of books are required to pay transportation charges each way and correspondents registered for the course in "Lumber and Its Uses" are charged a fee of $5.00 to cover books and material used. A small wood collection is put into schools and other organizations at actual cost, which is 50 cents.

There are two big organization problems in extension along forestry lines at present. The first one is the gathering and distribution of the best and most usable information. That is, the problem of keeping the workers properly "loaded" and at the same time out of the rut where a proper "load" will tend to keep them. To explain my rather clumsy figure further, I may say that extension foresters must not generalize so much that they merely entertain and they must not be so "technical" that their talks go over the heads of their audiences. A peculiar type of man must be developed for the ideal worker would combine wide knowledge and experience with broad sympathies, keen interests and ability to meet people in a friendly way. The greatest lack at the present time among men available for this work is actual knowledge and experience in forestry.

The second problem is that of following up the work which has been started by means of lectures, demonstrations and study courses in various centers. If the eternal remark "Forestry is a very important subject" is the only result of a visit to a community further lecture and demonstration work is necessary. On the other hand if some local man resolves to

manage his farm woods according to forestry principles, or a school wants to plant some idle land next spring, or the people of the village want to make their idle watershed pay, some local organization such as the County Farm Bureau, the Boy Scouts or the local Chamber of Commerce must be interested and led to cooperate. Cordial relations are not always easy to establish, but careful study of any given community and prompt attention to resulting correspondence will accomplish much in this direction.

Forestry stands coordinate with agriculture as a solution for the problems involving the use of land. As such it offers an unlimited field for the creation of public sentiment which when crystallized into action is the mightiest force which man can summon. This year the foresters from the college will probably reach from 50,000 to 75,000 people in one way or another. I know of one forester who, when it is all over, will scratch his head and wonder just where the results will show. He will probably be able to say that as a direct result 50,000 trees have been planted by schools and land owners, thirty or forty people have been sufficiently interested to join either the State or the American Forestry Association, fifteen woodlot owners have found a market for their dead and down timber, a dozen boy scouts have passed their tests for a forestry merit badge, three villages have passed shade tree ordinances and two clubs have taken up forestry for their next year's study subject and then as he goes home and saws up some of his six dollars a cord fire-place wood which came from a piece of farm woods blown down by a hard wind last summer, he will begin to figure the further results. He will know that five or ten years from now a couple of thousand citizens of New York State will be voting right on the initiative measures calling upon the state to do telling reforestation work on its idle lands, calling for tax reform that will allow the practice of forestry on private lands at a larger profit. That some twenty or thirty farmers will then be saying "By George, I've got to plant me some trees. Look at the ones Neighbor Jones put out ten years ago." That the citizens of ——— will be looking at their avenues of Oriental planes and calling their "City Dads" blessed for not planting Carolina poplar. That the State Forestry Association has a

membership of ten thousand and that the 14,000,000 acres of land better suited to forestry than to agriculture are gradually becoming busy at their one best job.

New York and other states need men for this work. Men who are up on the best modern forestry thought who are as versatile as possible, endowed with vision and enthusiasm and who will not be sunk by any brand of pessimism afloat.

The annual convention of the Iowa Forestry and Conservation Association was held in Ames February 2, 1916. The principal topics for discussion were:

The Proposed National Park for Iowa;
The Conservation of the Iowa Lakes;
County and State Parks and Forests;
The Conservation of the Beauty Spots of the State.

The movement for the establishment of a National Park in northeastern Iowa, the Switzerland of the State, as Senator W. S. Kenyon has called it, was given hearty support.

The Forestry Section of the Iowa Experiment Station issued two bulletins written by G. B. MacDonald during the last year. The two publications give the results of a very comprehensive study of the preservative treatment of farm timber and the renewal of windbreaks. The Experiment Station has undertaken the reforestation of the sandy lands adjacent to the Mississippi River in Allamakee County. Eight species of conifers are being tried out in plantations. In the same region a large amount of cottonwood is planted in the overflowed island lands. Cottonwood makes sawlogs in from twenty-five to thirty years.

Carolina poplars put out on the College farm at Ames in the spring of 1910 have yielded fenceposts in five years. Five hundred and forty posts with a diameter of 3½ inches and 720 posts with a diameter from 2½-3½ inches were produced on one acre. If given a good creosote treatment costing from 10-20 cents apiece, the posts will last from 20-25 years.

The Woodlot in Relation to Farm Management

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When one thinks of forestry, lumbering, and kindred subjects there come to mind pictures of a wild and distant region, pioneer conditions and things done on a huge, rough scale. The idea of forests and their utilization seems inseparable from that of vast tracts of timber, remote from settlements and cultivation. Particularly does this seem true to dwellers of the prairie who are not usually familiar with timbered regions. In fact it is true to a large degree, for many extensive forest areas are wildernesses, rough and mountainous, and most of the lumbering is done under pioneer conditions. In other places lumbering is the forerunner of cultivation as in the central hardwoods and southern pine belt where the topographic and climatic conditions are favorable.

While this is true, that many forests are in wild places and lumbering most frequently carried on remote from cultivation and settlement, yet there are also many thousand small bodies of timber distributed among the farms in the cultivated districts which are in eastern sections called "woodlots." These tracts of timber are intimately connected with the farm and its management and are usually remnants of a more extensive forest which has been gradually cleared away to make the farms. On the prairies they are, for the most part, planted.

These small tracts of timber are a part of the forest wealth of the country and their disposal and treatment is of both public and private concern. On account of their location and distribution the utilization of the woodlots is different from the use of large lumbering tracts, as a rule, and is closely related to the general system of management of the entire farm in their respective localities.

In the aggregate those small woodlot holdings are enor-

mous and have until recent years received insufficient consideration. Lately attention has been directed to their importance and value and a number of publications by the states and Federal Government have been published or are now in the course of preparation. Most of these publications deal with the marketing of the timber products as this is the feature in which the owners are most keenly interested at the present time. It is the feature whose realization is forced by the practical necessities of the present moment while the care and management of the woodlot as a permanent source of income and general advantage to the farm, is overlooked. The latter feature is of equal importance and is primary where the woodlot is to be maintained as a permanent part of the farm and not regarded as a stage in its improvement by clearing, and consequent extension of the cultivated area. To secure reliable practicable information on all sides of the subject its study has been followed in a number of directions.

The phase under discussion in this paper has been designated woodlot economics, and seeks directly to correlate the practical economic management of the woodlot with that of the farm to which it belongs and indirectly to the general community. It was inaugurated at the beginning of the field season in 1915 by the Forest Service and the Office of Farm Management of the Department of Agriculture as a co-operative project. So far the study has been confined to the general eastern half of the country, extending as far west as the prairie states. As stated before this work deals mainly with the economics of the woodlot and is a carefully planned attempt to secure definite figures and basic facts on woodlot and farm management conditions from the field and on a number of selected representative localities and to correlate and compare the information obtained.

The method of doing the work was developed from a number of conferences between the two offices directly concerned in which the lack of essential data of this character was shown, the points needed and means of securing them gradually worked out. Some forty or fifty questions designed to bring out information along specific lines were framed up and placed on a set of cards for use in the field. Answers to the

same questions will be obtained from 50 to 75 farmers in each selected locality and the results tabulated.

While it is perhaps not necessary here to give each question, they cover the following points: size and value of farm, distance to market, description of soils and topography of farm and woodland, different kinds, size and age, density of stocking, and an estimate of its value, also an estimate of the value of the woodlot for windbreak and shade purposes. Questions are asked on the pasture value of the woodlot, how many mature animals it will support through the pasture season and the proportion this amount is of those pastured on the entire farm. Another point to complete the survey of the woodlot value is the amount of land in it which can be cleared and make good farm land.

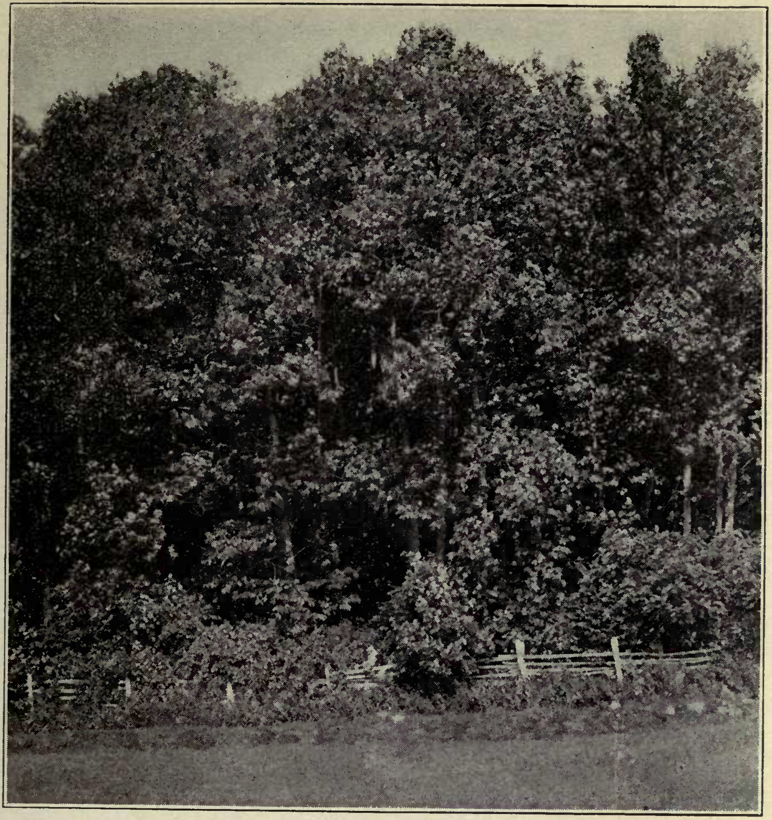
A classification of land on the farm is made as to acreage and value: plowland, permanent meadow, permanent meadow not in pasture, woodland pastured, woodland not pastured, and waste land.

In addition to the indirect advantages and values enumerated, a careful canvass is made of the average quantity and value of the woodlot products used and sold annually, such as firewood, fenceposts, poles, railroad ties, lumber, maple sugar products, etc.

In a line of inquiry to develop the advantage of the woodlot in furnishing labor to the farm at slack times, information is requested as to the number of days work obtained annually in harvesting and marketing woodlot products for man and team, the season at which the work is done, the kinds of winter work available on the farm and whether they serve to keep the farm force occupied through the winter.

Information in regard to the amount and character of the annual expense in keeping up the woodlot is asked. This includes usually taxes, fences, supervision, etc.

Three questions are asked which are designed to bring out the permanency of the woodlot; the number of acres of woodlot actually needed to supply the needs of the farm for woodlot products, whether the present woodland is preferred left in woods or cleared and used for other purposes, as for pasture if not suitable for cultivation, and how many acres now clear



By courtesy U. S. Forest Service.
Chestnut anl mixed hardwcod woodlot. Well protected. Litchfield County, Conn.

By courtesy U. S. Forest Service.
Beech wcodlot, not properly protected or handled. Henry County, Indiana.

on the farm and in pasture or crops which the owner believes should be in woods. The foregoing questions comprise practically all the information requested.

Of the sixteen areas selected for field work, seven were completed the past field season. They are as follows: northeastern Connecticut, northern Vermont, southeastern Pennsylvania, central Indiana, central Piedmont region in North Carolina, the coastal plain at the junction of the fall line in northern South Carolina, and central Tennessee. The nine areas which remain are distributed as follows: northern Alabama, northern Louisiana, southern Missouri, southern Indiana, northern Indiana, northern Wisconsin, southern Minnesota, eastern Iowa, and southeastern Nebraska.

These areas are confined to a county and are carefully selected for soil, topography, timber conditions, type of farming, and general economic conditions. The Connecticut locality, Windham County, is in the heart of a manufacturing district whose power is largely furnished by waterfalls along the stream courses. The population of the county is 48,361 and markets are good, both local and distant. According to the census 37.6 per cent of the area is wooded and the present survey of a portion shows the percentage of wooded area as 35.3. For the entire State of Connecticut the percentage of farm homes to total homes is 10.6 per cent and is decreasing slightly; 31.2 per cent of the owned farm homes in the county are encumbered, and 13.4 per cent of the farm homes are rented. The land is generally rough and stony with many granite ledges. The usual northern hardwoods are found, of which chestnut forms a large proportion. White pine occurs in the northern part. Fuel wood, lumber, ties, fenceposts, and poles are the principal products. Dairying is one of the important farm industries and pasture is in demand near the towns.

The Vermont locality, Franklin County, is much the same general type as the Connecticut, with the exception that there is very little manufacturing. Dairying is one of the principal industries and maple sugar making furnishes work in the early spring. In the part of the county where the information was collected the farm land is about the average for the

county as it is located between the best farming part and the hilly timbered part. The population of the county is 29,866 and decreased 1.1 per cent during the decade from 1900 to 1910. The census gives 21.1 per cent of the county wooded and the present survey gives 25.4 per cent. The percentage of farm homes to total homes for the entire State is 36.6 and 47.4 of the farm homes of the county are encumbered. 24.9 per cent of the farm homes are rented. Much of the land is ledgy but on the whole is much better than the locality in Connecticut.

The northern half of Chester County, which is the locality chosen in southeastern Pennsylvania, is in a highly developed farming region where progressive methods are followed and the population frugal and industrious. It is a dairy and grain raising region with hay and cattle growing to some extent. Since the county is near Philadelphia and well cultivated, the population is large, 109,213. For the entire State the per cent of farm homes to total homes is 13.1 and has decreased slightly since 1890. The per cent of farm homes encumbered in the county is 55.7 and 29.1 per cent of the farm homes are rented. The per cent of wooded area is given by the census as 12.2 and by this survey as 17. The greater part of the land in the valleys is tillable but the ridges are usually timbered and not capable of cultivation. The forest is hardwood with large home consumption and ready sale in most of the locality.

Madison County in central Indiana is the locality chosen to represent the best farming part of the State. It is a flat, fairly fertile region originally solid forest with much wet ground. The census shows now 11 per cent of the area wooded and the present survey shows practically the same 10.9 per cent. The population of the county is 65,224. For the entire state the percentage of farm homes to total homes is 32 per cent and has decreased from 44 per cent in 1890. In the county 35.5 per cent of the farm homes are encumbered. 36.1 per cent of the farm homes are rented. The timber is all hardwood and belongs to the general oak-hickory formation, with many species of hardwoods associated, as beech, ash, and maple. While the markets are good as a rule for imple-

By courtesy U. S. Forest Service.
Sugar maple grove, Orange County, Vermont.

Photo by W. R. Mattoon.
Badly eroding, clear cut, steep slope. Protective work with brush not entirely successful. East Tennessee.

ment and handle stock, there is practically no market for fuel wood and little use for it on the farms as coal and gas are generally used. This county is in a gas region and had a boom about 20 or 25 years ago and considerable local natural gas is still used for fuel on the farms. A pipe line from West Virginia supplies the towns with gas and some of the farms. Where gas is not available coal is used, which leaves little room for wood fuel, cutting off the opportunity to dispose of waste wood in the woodlot. Another important point is the character and high price of the land on which the woodlot is situated which greatly increases the carrying charge for taxes and makes it necessary for the woodlot to compete with cultivated land in returns. The tendency here is to clear out all the land for cultivation in order to secure the greater returns yielded by annual crops.

The locality which is chosen for the Piedmont Region on the Atlantic coast is Randolph County in central North Carolina. It is in rather a remote region of rolling and hilly land fairly typical of a certain section of the Piedmont. The census gives 60.7 per cent of the area as wooded and the present survey 58 per cent. The population of the county is 29,491 and is increasing slightly. The percentage of farm homes in the entire State is 55.5 per cent and has decreased but slightly in the last census decade. The percentage of farm homes encumbered is 19.3 per cent for the county, and 21 per cent of the farm homes are rented. There is very little stock raised in the county except that needed for home use. The wild pastures are not of great value and most of them are not fenced. As there is a stock law in force the unfenced pastures can not be utilized. Agriculture in general is in somewhat primitive state. The home consumption of fuel wood is large, as most of the farms as well as many of the town residences have fireplaces. A market exists for fuel wood, implement and vehicle material, but in many cases the hauling distance is too great.

Marlboro County in northern South Carolina at the edge of the "Fall line" is the locality selected for the Coastal Plain. It is in the cotton belt and with very fertile land for the most part. The county was once covered with longleaf and loblolly pines, with hardwoods in the wetter parts. Cot-

ton growing is the chief industry although some corn and other crops are grown. Most of the holdings are large plantations and worked by tenants. The population is 31,189, showing an increase in the last census decade of 12.8 per cent. The census gives 32.3 per cent of the area wooded while the present survey shows 42.2 per cent. The percentage of farm homes to total homes is 53.4 per cent, and 17.6 per cent of the farm homes are encumbered. 81.5 per cent of the farm homes are rented. The markets are not particularly good except for lumber but there is a large use of fuel wood on the plantations. Most of this land will be cleared up in time except the swamps which are difficult to drain.

Rutherford County in central Tennessee represents the southern extension of the central hardwood forest. Red cedar is also a well developed type and figures prominently in the use made of the woodlots. The locality is in the limestone district and the soil is fairly fertile, except where the bed rock is near the surface, where occurs what is known as "glade" land. Phosphate deposits occur in the extreme western edge of the county. The surface is mostly rolling with some of the land quite hilly around the edges of the county. There is some cotton raised in parts of the county but the most general industry is the production of grain, hay and live stock. Some dairying is done and is likely to increase. The population of the county is 33,199. For the entire State the per cent of farm homes is 51.1 per cent; 12.1 per cent of the farm homes are encumbered and 42.3 per cent of the total are rented. The wood market is fairly good and large quantities of red cedar posts and poles and hardwood material are used. There is a strong tendency to clear off the land for cultivation and pasture, for the latter purpose even when of the most rough and stony character.

Of the localities remaining, from which data has not been obtained, the one in northern Alabama represents the hilly section along the Tennessee in Morgan County, with a certain type of soil and methods of farming. Ouachita County in northern Louisiana represents the western extension of the southern pine belt with associated swamp hardwoods. A county in southern Missouri is chosen to represent the general

Photo by W. R. Mattoon.
Farm buildings and woodlot of a progressive farmer, East Tennessee.

Photo by W. R. Mattoon.
Six hundred cords of chestnut acid wood in the yard of extracting plant, Carter County, Tennessee.

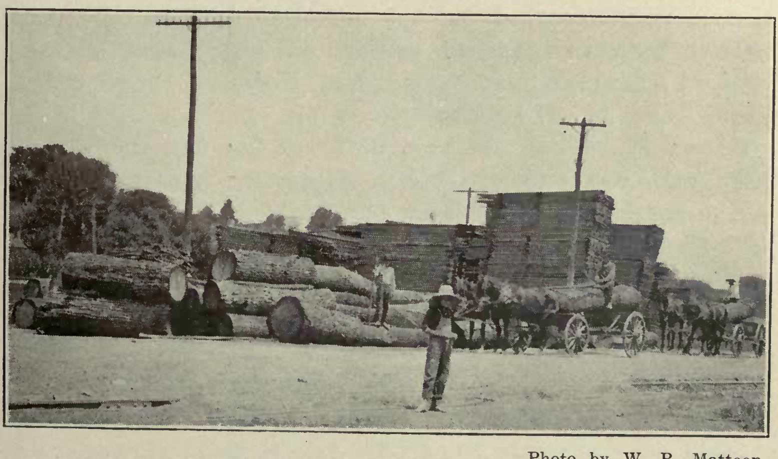


Photo by W. R. Mattoon.
Hauling red and white oak logs to railroad, Jonesboro, Washington County, Tenn.

Ozark region of Missouri and Arkansas. There are two counties selected for Indiana, one in the southern hill portion and the other in the northern part. These counties are in addition to the one already canvassed for the central belt and all three represent belts which extend outside the State. One locality is chosen in northern Wisconsin to represent the timber and farming conditions of both northern Minnesota and Wisconsin and one for the southern part of Minnesota. The two remaining localities represent conditions in the prairie region and will be selected in eastern Iowa and southeastern Nebraska.

One of the main objects of the study is to show the capitalized value of the woodlot land based on net returns from the products and an interest rate of 5 per cent compared with the actual sale value of woodland. In arriving at this value the gross value of all woodlot products, used on the farm and sold, is found and from this amount is deducted the cost of maintaining the woodlot and the labor cost of getting out and marketing the products. For the Connecticut locality the estimated value of woodlot land average $8.13 per acre and the capitalized value of $10.80, leaving a balance of $2.67 per acre in favor of the woodlot business. This is due to the fact that the land is rough and ledgy with low farming values. In the central belt of Indiana the farming values are high with level fertile land easily cultivated which makes the showing decidedly against the woodlot on a strict financial basis. Here the average estimated value of woodlot land per acre is $128.31, and the economic value $26.20, leaving a balance against the woodlot of $102.11. In other words, land which will sell for $128 per acre is used for woodlot purposes giving returns on a $26 per acre valuation only. The character of the land and its suitability for farming determines largely the value of the woodlot business. In Chester County, southeastern Pennsylvania, there is good farmland but the woodland is usually on the rougher parts. Here the values are more nearly equal as the estimated value per acre is $18.16 and the economic value $28.40, leaving a balance in favor of the woodlot of $10.24. In central North Carolina the economic value is low—$5.80 per acre—and the balance

against woodlot is $6.40. This is mainly due to lack of market and low value of fuel wood.

If the direct returns included all the values and advantages of a woodlot on a farm, the showing would be good for the timbered districts where the land is not agricultural in character. But there are other advantages to the farm as a whole, such as shade for stock, protection from storms, pasture value, prevention of erosion on steep slopes and utilization of inferior land of little or no value for other purposes.

Where the woodlot is perhaps related most closely to the welfare of the farm in its intelligent and systematic management is in furnishing work for men and teams through the slack period, usually the winter. Even where the returns are only sufficient to pay the expenses or part of the expenses of the labor in getting out the material it raises the total income of the farm as the expenses of carrying necessary work stock, and help through the winter are eliminated or reduced.

The convenience of a ready supply of wood material at wholesale cost for repairs on the farm is no small item, particularly in the rush season.

The following are important points relating to the management of the farm and woodlot:

1. Region where located, whether generally timbered or untimbered.
2. Agricultural value of the land—its fertility and ease of cultivation.
3. Whether there are home needs for woodlot products and a steady market value for the surplus.
4. Value of direct returns including wood products used at home and sold.
5. Protection value, i. e., windbreak, shade and erosion.
6. Grazing value.
7. As a means of fully utilizing inferior land on the farm.
8. As a means of furnishing labor for idle help and work stock through the winter or other slack period.

The Des Moines Sawmill Co., Iowa, it is reported, manufactures more gunstocks than any other factory in the world.

Grazing Resources and their Utilization on the Wallowa National Forest

E. H. STEFFEN, '13
U. S. Forest Service

It had always been the custom for settlers to graze their stock on the vacant public lands near the settlement without supervision or restraint, and it naturally followed that when National Forests were created and the areas closed to certain classes of stock and the grazing of all stock restricted, much opposition arose. Prior to 1897, all National Forests were closed to sheep grazing, on the supposition that this class of stock was injurious to the forest cover. This was true to a certain extent, but the damage in most cases was due to the method of handling the stock. In 1897, the forests in Oregon and Washington, and later the other National Forests, were opened to sheep, and since the advent of the regulated use of forage, there has been very little material damage to the forest cover, and the almost depleted ranges are gradually returning to their normal vegetative cover.

It is true that we must have trees and lumber, but we must also be fed and clothed, and the meat and wool producing powers of the forage on the National Forest lands is too great to be lost sight of. According to the Forester's report there are at present some 7,280,000 sheep and goats, and 1,725,000 cattle and horses and their additional increase, which range on the National Forests. Grazing should, therefore, not be considered as an accident to National Forest administration, but as a legitimate aid in capitalizing an enormous forage resource, and an important adjunct in the proper control of fires.

Up to the present time, the utilization of the grazing resources has been the major activity on the Wallowa National Forest. While there are some fairly large bodies of good timber here, there has heretofore been no call for it except a

limited amount for local consumption. Now, however, a timber sale of approximately 120,000 M. B. F. is under way. The larger portion of the area of this Forest is chiefly valuable for watershed protection and the forage over the entire area. The geological formation and consequent topographic conditions of this region are in a large measure responsible for the value of this Forest from a grazing standpoint.

The entire Forest is part of that great lava flow known as the Columbia River plateau which covers 250,000 square miles of this northwest territory. This great lava flow surrounds several prominent mountain ridges which stand out boldly. Of these mountain ranges, the Wallowa mountains are mostly within the boundaries of this Forest.

The entire Forest lies within the Snake River drainage area —Snake River itself forming the 70 miles of eastern boundary. Along the boundary the river has a comparatively low elevation of from 900 to 1600 feet above sea level. From Snake River the elevation rises by successive stages to about 10,000 feet in the Wallowa mountains with a consequent variation in climate. It is this variation in climate that makes this Forest of particular value from a grazing standpoint.

The precipitation of the region varies from 12 inches at the lower altitudes to 30 inches or more on the high mountains, and either dry farming methods or irrigation are resorted to on the ranches within or adjacent to the Forest.

While the timber values of this region are great, it is probable that the community and its development are more dependent on the stock-raising industry than on any other one thing, and the forage on the National Forest lands is the greatest item in the stock-raising industry of this region, comprising, as they do, a large percent of the available range. Previous to the creation of this Forest there was a mad scramble for the range, without system or regulation. This state of affairs continued for years with a consequent depletion of ranges and a gradual diminution of the forage resources on which the community development is dependent. It is safe to say, that had not the National Forest been established and grazing regulated, much of the available range would have been ruined.

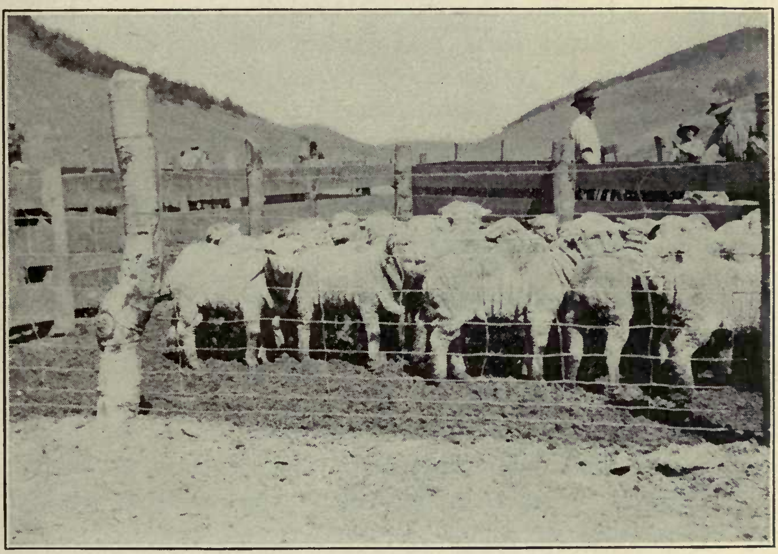


Photo by E. W. Nelson.
A valuable product of the National Forests. A flock of young sheep ready for shipment.

The grazing plan for this Forest for the coming year recommends that 19,000 cattle and horses, 105,000 sheep and 100 swine be allowed to utilize the ranges on this Forest, which in itself is an indication of its forage resources.

The range as a whole may be roughly divided as follows:

Summer, cattle and mutual, (includes spring and fall sheep range	380,000 A.
Summer sheep range	320,000 A.
Winter cattle range	150,000 A.
Winter sheep range and lambing grounds	160,000 A.

The northern portion of the Forest, comprising about 13 townships, is mainly a plateau area, from which the drainage flows southerly into the Wallowa valley, or northerly into the Snake River. This plateau area has been only slightly dissected by erosion, and only a few deep and prominent canyons are to be found in this region, and these do not grow deep until they near the northern boundary of the Forest. It is on this area that the accessible merchantable timber is to be found.

To the east and south of this plateau area lies Snake River and its tributary canyons. This area is geologically similar to the northern plateau, but is more deeply dissected, and while some fairly large flats occur in the region, it as a whole consists of long narrow ridges and deep canyons, with narrow valley floors. From Snake River the walls of the canyon rise more or less precipitously to a height of from 5000 feet to 7100 feet above sea level. Numerous bench areas are to be found in the canyons, parts of which are suitable for agriculture. This deeply dissected plateau area leads up to the Wallowa mountains which are very rugged and large areas are barren or at best support but a scanty plant growth.

Roughly, the Forest lies in the shape of a horseshoe surrounding the Wallowa valley and the rolling hills to the east of it, to which the major portion of the settlement of this region is confined.

The summer cattle and mutual ranges, parts of which are used as spring and fall sheep ranges, are confined to the more accessible timbered northern plateau area, and the larger of the flats in the more deeply dissected region lying to the

east and south. Some of the larger flats are also used as summer sheep range.

The types on the summer cattle range may be divided into three broad classes, grass, browse and weed types, in order of importance, all being timbered types. On the northern plateau area the larger percent of the area consists of an almost pure stand of pine grass, and in point of area, it is also probably the most important type on the Forest. The composition of a typical pine grass type is about as follows:

PINE GRASS

	Per Cent
Surface supporting vegetation	90
Average density	80
Palatability	60
Timber, yellow pine, Douglas fir and larch.	

Grasses 70%	%	Weeds 15%	%	Browse 15%	%
Pine grass	90	Alum root	25	Chaparral	25
Koelaria	10	Arnica	20	Large huckleberry	20
		Bluebell	5	Spiraea	10
		Yarrow	10	Willow	15
		Everlasting	10	Kinnikinnick	30
		Clover	10		
		Lupine	10		
		Geranium	10		

Of the browse types the large huckleberry and small huckleberry are by far of greatest importance on the summer cattle range and spring and fall sheep range, though the browse types along the creeks are in the aggregate quite important, and help to make up a proper balance of the different classes of forage on any allotment.

The following may be taken as typical browse types:

LARGE HUCKLEBERRY

	Per Cent
Surface supporting vegetation	70
Density	90
Palatability	60
Timber: Lodgepole pine.	

Grasses 5%	Weeds 5%	Shrubs 90%
Pine grass	Clover	Large huckleberry
Sedge	Strawberry	Willow
	Potentilla	Sevenbark
	Arnica	

BROWSE (Along Creeks)

	Per Cent
Surface supporting vegetation	90
Density	70
Palatability	30

Grasses 15%	Weeds 15%	Shrubs 70%	%
Pine grass	Aster	Thimbleberry	10
Sedges	Potentilla	Currant	10
Bromus	Senecia	Mock orange	20
	Clover	Gooseberry	10
	Arnica	Spiraea	5
		Serviceberry	10
		Willow	10
		Maple	10
		Rose	5
		Alder	10

SMALL HUCKLEBERRY

	Per Cent
Surface supporting vegetation	60
Density	40
Palatability	30

Timber: Lodge pole pine.

Grasses 10%	Weeds 15%	Browse 75%
Pine grass	Lupine	Small huckleberry
	Fireweed	
	Anophilus	
	Arnica	

It may be said of the small huckleberry type, that it is practically worthless from a grazing standpoint, and it occurs principally on the higher spring and fall and some of the summer sheep ranges in the neighborhood of the high mountains.

In the spring and early summer, as soon as the forage on the respective ranges has attained a sufficient growth to prevent excessive injury by grazing and trampling, the stocks are allowed to drift or are driven from the low winter ranges onto the higher ranges. This generally takes place during April and May for cattle, and the sheep go on the summer range in late June or early July. The type of forage on this class of range necessitates that it be used as early as possible, since pine grass in its early stages of growth is quite palatable and succulent, but later on as the dry summer weather continues, pine grass becomes more harsh and loses its palatability and forage value to a large extent, and while the stock do not relish it under these conditions, they will graze

it when forced to do so. Supplementing the pine grass type and adding much to the forage value of the entire area are the different shrubs and weeds which are found in mixture with the pine grass in the pine grass types and the more or less pure types of browse and weeds, the composition of which have been previously given. These supplemental types are to a large extent responsible for the value of this class of range, since they maintain a proper balance between the different classes of forage, and increase the value considerably.

It has been noted on this Forest in two widely separated areas that where pine grass has been heavily overgrazed, a species of small clover supplants the original pine grass type to a large extent. This condition has increased the carrying capacity of these ranges to a considerable extent, since the clover type which has come in is much more palatable than the original pine grass type, and remains palatable for a greater period of time, and grows up again in a short time after being grazed, if moisture is to be had in sufficient quantities. This case is practically the only one where it is known that overgrazing in any form is beneficial in any way. Generally, overgrazing causes a diminution of the more valuable forage plants, and an increase in the percentage of less valuable species.

Cattle and horses occupy the summer range from about May 1 to October 31, and the efficient use of the range by this class of stock depends upon the method of handling. Horses and cattle, not being under constant supervision as are sheep, naturally occupy the areas easiest to graze. In the beginning they are distributed over the range as evenly as possible and their future movements are regulated as much as possible by drift fences supplemented by occasional riders, and to a larger extent by watering facilities and the proper location of salting places in relation to available water. During the summer season cattle require about 10 pounds of salt per head, and should they receive an inadequate amount they will not do their best, and become uneasy and travel too much and will not put on fat, nor will they use the range to the best advantage. It is possible by correct location of salting grounds to force the cattle traveling between salting and watering places to

utilize much range that they would not go over if salting grounds were not correctly located. The development of watering places is also a great asset in the proper utilization of the range in this respect.

Sheep using the summer cattle and mutual ranges use their allotted portions first early in the spring, shortly after lambing, thus supplying the tender feed much needed to keep the ewes in good milk-giving condition, and to supply the lambs with succulent forage which is necessary during the first few months of their existence. On the supply of tender forage at this period depends to a large extent the growth and development of the lambs. When the snows have melted on the high mountain sheep ranges and the areas at the foot of the mountains, the ewe bands with lambs leave the summer mutual ranges for the high summer ranges, where they continue to have an abundance of tender palatable forage.

In the fall when the sheep have been driven off the high summer ranges by the snow, the ewes and the remaining lambs (some of the lambs having been cut out and sold) are driven back onto the mutual ranges to utilize such portions of the range as have not been fed off by the cattle and horses.

Though sheep utilize, during the summer months, much of the range previously described, the typical summer sheep range is confined to the high mountains whose difficulty of access and ruggedness precludes the use of the area by other classes of stock, though there are areas—especially the basin areas at the head of streams—which are covered with excellent forage, and which could be easily utilized by cattle.

The sheep are driven to the high summer ranges about July 1, utilizing first the lower slopes and canyon bottoms, and progressing upward as the heavy winter snows melt, and the forage develops.

It is rather difficult to make a general classification of the types in this region, but a few of the more important ones will be outlined. First in importance from a forage value standpoint comes the mountain bunch grass type, the principal forage plant of which is mountain bunch grass (Festuca viridula).

MOUNTAIN BUNCH GRASS TYPE

	Per Cent
Surface covered	60
Density	80
Palatability	80

Timber: Scattered white-bark pine, lodgepole pine and alpine fir.

GRASSES 70%	WEEDS 15%	SHRUBS 15%
Festuca	Everlasting	Sage
	Yarrow	
	False alum root	

GRASS-WEED TYPE (Found along some streams)

	Per Cent
Surface cover	90
Density	90
Palatability	80

Timber: Scattered mature Douglas fir, western larch, Engelmann spruce, and seedlings, saplings and poles of lodgepole pine, western larch, Douglas fir and Engelmann spruce.

GRASSES 70%	WEEDS 30%	
Wheat grass	Hellebore	Anophilus
Cheat	Giant larkspur	Drymocallis
Blue grass	Mallow	Nettle
Tickle grass	Strawberry	Niggerhead
	Bluebell	Meadow rue
	Sego lily	Dandelion
	Hydrophyllum	Geranium
	Antenecia	Yarrow
		Fire weed

GRASS (Timbered)

	Per Cent
Surface covered	80
Density	80
Forage plants	80

Timber: Lodge-pole pine, white and Douglas fir.

GRASSES 60%	WEEDS 40%
Fescue	Pentstemon
Pine grass	Wooly weed
Blue grass	Alum root
Sedges	

MEADOW TYPE (no timber)

	Per Cent
Surface covered	100
Density	100
Palatability	70

GRASSES 35%	SEDGES 35%	WEEDS 25%	SHRUBS 5%
Poa	Various species	Drymocallis	Mountain heath
Agrostis		Gentian	
Others		Strawberry	
		Others	

BROWSE TYPE

	Per Cent
Surface covered	100
Density	90
Palatability	50

No timber. (Scattered Douglas fir saplings.)

GRASSES 35%	WEEDS 25%	SHRUBS 40%
Pine grass	Columbine	Aspen
Bromus	Sego lily	Willow
Rye grass	Geranium	Ceanothus
Fescue	Yarrow	Buckbrush
	Senecio	Large huckleberry
	Peavine	
	Paint brush	
	Valerian	
	Strawberry	

WEED TYPE

	Per Cent
Surface covered	60
Density	70
Palatability	50

Timber: White fir, lodge-pole pine, Engelmann spruce.

GRASSES 20%	WEEDS 60%	SHRUBS 20%
Blue grass	Meadow rue	Small huckleberry
	Monkshood	Currant
	Valerian	Spiraea
	Saxifrage	Serviceberry
	Strawberry	

The return from the lamb crop is largely dependent on the handling of the ewe bands with lambs on the summer ranges. It has been noted on this Forest that lambs from two different bands of the same breed of ewes having equal chances on like ranges have in the fall differed in average weights as much as 17.7 pounds. This difference in weight can therefore be due to one thing, that is, faulty handling of the sheep. It might also be said here that lambs grazed outside the Forest weighed 64 pounds, while those grazed inside the Forest on like range weighed 67½ pounds at selling time. From the summer ranges the sheep are driven back to the lower fall sheep and mutual ranges, and in this way are able to utilize the forage not touched by cattle during the summer. Neither the ewes nor the remaining lambs are, at this time, so much dependent on succulent forage for proper growth and development, and can therefore utilize the left-over areas to good advantage. Here they remain until the snow forces them to seek the open winter ranges at the lower altitudes.

A large percent of the winter range of this region is within the Forest boundary, and lies along Snake River and the deeper of its tributary canyons. The small amount of precipitation at the lower elevations at which the winter range lies precludes the growth of much timber, and consequently the range is all of an open bunch grass type, the composition of which is in the main largely as follows, varying to a certain extent on account of the directions of the slope which it occupies:

OPEN BUNCH GRASS TYPE

	Per Cent
Surface cover	90
Density	90
Palatability	80

Grasses 70%	Weeds 20%	Shrubs 10%
Wheat grass	False alum root	Serviceberry
Koeleria	Yarrow	Rose
Carex	Lupine	Tassel bush
	Club moss	Maple
	Potentilla	

The value of the winter range, as far as the forage value of the types is concerned, is all in all nearly equal, but the direction of the slope is the one salient feature about the winter range that must be taken into consideration in allotting the range and the handling of the stock thereon. Slopes having a northerly exposure are naturally cold, freeze up early and remain frozen during the colder winter months, which prevents the new growth of grass to a very large extent. It is a peculiar fact that the grasses on the north slopes have a carrying capacity of not more than half that of the south slopes; while no investigation has been made to determine the truth of this statement, it is well known to stockmen that the slopes with a northerly exposure being frozen are dangerous for stock to encroach upon, because of the danger of sliding and consequent loss. On the winter range each band of sheep have an individual allotment, as they also do on the summer ranges.

The method of handling cattle on the winter range differs widely from the method used on the summer range. In allotting the summer range, allotments are large and are used jointly by a group or an association of permittees. The winter

cattle allotments are individual; that is, each permittee is allotted a piece of winter range as near his home ranch as possible, so as to enable him to look after his stock during the dangerous winter months, and develop his range to the best advantage, and so that he may eliminate to a large extent any loss by sliding, by fencing off the slopes where loss by such accident is liable to occur. By having his stock confined to an area near the home ranch during the winter months, it is a simple matter for him to collect the animals and feed them hay or other forage crops raised on the ranch, should occasion demand.

The amount of winter range being inadequate in proportion to the summer range, it is necessary that a large part of the stock grazing the summer ranges be driven to the ranches in the valley and surrounding foothills to be fed during the winter.

To illustrate some points of management and utilization and some of the results obtained for Forest Service administration, there is inserted here what Ranger Winniford has written about the Snake River Live Stock Association.

"A particularly good example of the beneficial results of stockmen working under the Forest Service administration, is on the Snake River range. Formerly there was very great uncertainty in the livestock industry on this range, regarding both summer and winter feed, and the effect was almost as bad on one range as on the other. This condition was due to two causes: first, the use of the winter range during summer. There were few, if any, drift fences, and the cattle were left on the range in the spring until they drifted back up the mountain side on to the summer range. There was very little incentive for a man to drive his stock out on the summer range, for his neighbors might object to the added expense and labor of keeping his stock on the mountain, or he might fear too great a loss, so that he would keep them around his ranch all summer,and let them drift back and forth over and ruin the range which should have been saved for winter. Fencing on the public domain was not allowed by law, and was therefore not resorted to. The range was therefore used just as it happened, without regard to when it was ready to use, or

economically most valuable. Second, on the summer range there was sharp competition between sheep and cattle, and the cattle were never able to put on fat. Then when they came down on to the winter range they were poor, and the range was bad, and many of them died from poverty, or slid off the steep hills and were crushed to death. No one expected to get any beef off the range. The administration of the Forest legalized drift fences, and this made it possible, not only to protect the winter range against destructive summer grazing, but to allow each permittee to protect his own winter allotment and build within it such drift fences as were necessary to keep the stock off dangerous sliding ground, and to so handle his stock as to secure the greatest amount of good from the use of the range. It also eliminated competition, protected the summer range for the stockman, insured the continuity of his business, and the fruitfulness of it. For some years each permittee was busy improving and developing his winter range. His stock now leave the winter range in good shape, but it was noticed that big steers, and in some cases, dry cows, did not put on enough fat during the summer to tempt the cattle buyer. Something had to be done. The Service encouraged the building of big drift fences which would separate the beef cattle from the stock cattle during the summer, and more uniform salting. It was a community matter, for the range was used in common by all the stock, and one permittee could not do the necessary work. An association was formed, and authorized the construction of the fence, which was built, and this served the purpose well, but it had to be paid for, and this disrupted the association, for the people were hardly ready for the progressive by-laws of the association. The association was pretty thoroughly dead, but the drift fence was working right along, and its good effects were so evident that as time went on the minds of all became more and more impressed with the good that it was doing, and at length the fence began to assume the form of a public necessity. Then came a time when it needed repairing. Everybody said so, and there were corrals to be built and repaired, business had been prosperous, so why not put up a good cabin at the head camp? The psychological moment had ar-

rived for the revival of the stock association, and the improvement of the summer range, if only the lid could be held down. The service encouraged the unenthusiastic, plead with the tight wads, and checked the radicals, and tried to harmonize the various elements. They were told that a permit for any special use would have to be held by the stock association if it was to be located on the summer range. The Stock Association was dead, it is true, but why not revive it? They did. They provided for more salt for the cattle, they planned water troughs, and made yearly programs for handling stock and using the range. They were all ready for the by-laws of the Association, and they felt at this time, with a recognized Advisory Board, the Stock Association could take a hand in grazing affairs. This gave the permittees a feeling of confidence. It began to look as if the beef cattle would always be of a quality that would demand a good price. Then why not further increase the price by breeding the stock up to a better standard, since better stock brought in better profits, and greater profits brought greater enthusiasm in the business. Now they are vieing with each other in suggesting improvements that can be made to benefit the range, and make the work of riding easier, so that still more time can be spent in improving conditions on the range. Prices are better now, and while this may be due entirely to market changes, no one hesitates about buying Snake River Stock, because they are a better grade than formerly. They are fatter than they used to be, they were never poor or hungry in their lives, their ranges are protected winter and summer, and their owners have confidence enough in their quality to demand the highest market price. Snake River steers sold as tops on the Portland market this fall. Conditions are still a long ways from ideal, but to deny that the administration of the Forest contributed anything to their betterment would be to deny that they have changed for the better at all."

The Forest Service administration of grazing lands has made it possible for the various sheepmen as well as cattlemen to plan definitely for the future, with the assurance that they will be allowed the more or less continuous use of the same range from year to year. This has stimulated the im-

provement of the range by the permittees themselves in the building of trails, and the development of watering places in co-operation with the Forest Service to open new and formerly unused range. Due to regulation, the former waste in the use of forage has been stopped. By assigning permittees to definite allotments, and by regulating the time that each camp on an allotment is to be used, the greatest good compatible with economic results is now obtained from all the range.

The educational features of the Forest Service administration should not be lost sight of. By experiment and by co-operation with the stockmen in all parts of the west, various problems in methods of handling stock on the range have been worked out, and are being brought to the attention of the users of the range. Among these problems may be mentioned:

1. Water development.
2. Salting; amount required, and best location for salting places in relation to watering facilities and forage.
3. Deferred and rotation system of grazing.
4. Bedding-out system of handling sheep.
5. Poisonous plant studies.
6. Forest Service influence in the destruction of predatory animals.

The regulation of cattle and horses on the various ranges by drift fences built through the co-operation of the members of the various live stock associations, has resulted in a great saving of time, money and forage, and in a considerable gain in beef.

The following figures taken from the Annual Grazing Report for this Forest will show approximately the value of the forage resources of the Forest to the community:

"The Forest will carry 6000 head of cattle yearlong. At 3 years of age they will be worth at the present market price, $60 per head, or $20 per year for the three years. This would amount to $120,000 for the cattle under year-long permit. 12,000 additional cattle can be cared for during the period from April 1 to November 30. As it would cost about $15 per head to carry them through each of 2 winter seasons, this would leave $10 yearly value through each of 3 years,

for the National Forest forage consumed, or an annual revenue of \$120,000. There is range for 34,000 head of sheep yearlong, and for 66,000 additional sheep during the season from June 1 to October 31. It will cost \$1 per head to feed these sheep during the remainder of the year. At two years of age each sheep would be worth, using present prices as a basis, \$5 per head, and would have sheared 15 pounds of wool at 20c per pound. This would make each sheep yield \$8 at two years of age, or \$136,000 for the yearlong sheep, and \$462,000 for the sheep grazed part of the season, or \$299,000 for one year. The grazing resources then will produce beef, mutton and wool valued as follows:

Cattle grazed yearlong	\$120,000
Cattle grazed during part of year, less amount required to carry them balance of year............	120,000
Sheep grazed yearlong, including 7½ lbs. wool each	68,000
Sheep grazed during summer, less amount to carry them balance of year	231,000
	\$539,000"

The Wallowa Forest and its adjoining agricultural lands in Wallowa County may then be described as an excellently balanced grazing unit, capable of supporting, when fully developed and utilized, 120,000 head of sheep and 25,000 head of cattle and horses. The farm lands depend upon the Forest ranges for the profitable utilization of their products, and without these products the stock could not so profitably utilize the forest ranges. There is enough hay raised to supplement the winter range and feed the farm stock, so there is practically a continuous balance in farm and forest during the entire year.

In 1915 the Forestry Club of Iowa State College became a member of the Inter-Collegiate Association of Forestry Clubs. T. W. Rehmann, who was elected local vice-president of the national organization, will represent Ames at the next convention of the association to be held at Seattle, Wash., in November, 1916.

Reforestation on the Minnesota National Forest

H. H. RICHMOND, '12
U. S. Forest Service

The Minnesota National Forest was created by an Act of Congress in 1902. It comprises a net area of 197,000 acres. The tract is located at the headwaters of the Mississippi River and aside from an economic standpoint, is valuable as a protection forest and also as a public recreation ground. It is known throughout the middle west and even on the Atlantic Coast as the playground of Minnesota. Its many lakes, its excellent beaches and bathing facilities, combined with a stand of virgin white and norway pine, such as can be found nowhere else in the United States, attract many tourists. As a result, during the past four years, two summer hotels have been constructed. In addition, thirty-five summer homes have been built along the lake shores by people from Minnesota, Iowa, North and South Dakota, Nebraska, Missouri, Illinois and even New York.

From an economic standpoint, the Forest is entirely accessible either by water or railroad. The Mississippi River flows through the center, while two railroads cross the Forest from East to West. It is bounded both North and South by waterways. The market for timber is unlimited and the quality of the stumpage is unsurpassed. No substitute can be found for white pine and as for norway, it is second only to the first named species.

The silvicultural system in vogue on the Forest consists of clear cutting with scattered seed trees. Until 1908, 5% of the entire stand was left as scattered seed trees, but after careful observations it was found that 5% was insufficient to restock the area. As a result a bill was passed which required 10% of the stand to be left instead of 5% as formerly. The scattered seed tree system has not proven an entire success on the Minnesota National Forest. It has had many oppon-

ents among the lumberman who could not understand such a system of management. It was necessary in marking the seed trees to leave many that were mature and over mature and of little value as seed producers. Many of the seed trees have blown down. After ten years of close observation, it has been found that the seed trees have been practically valueless. On the other hand, the policy should not be condemned because it has been one step—a great stride—toward the advancement of Forest management. It is needless to quote statistics or dwell upon the causes and results of the failure.

In July, 1915, the writer spent several days with Mr. Raphael Zon in examining cutover 5% and 10% areas. Not a single instance could be found where reproduction could be attributed to the seed trees. A good seed year occurred in 1910 and accordingly, examinations were made upon areas that were logged in 1909, 1910 and 1911. On one particular area where the logging had been done in the winter of 1910 and 1911, a fine stand of reproduction covers the ground. The entire stand produced the seed and it cannot be attributed to the 10% left as seed trees. The seed was on the ground at the time of logging and the same results would have been accomplished had the area been clear cut. Examinations of all other areas proved the seed trees valueless. Under present conditions, there is little or no chance for the seed trees to restock the area. The ground cover has grown up very dense and in addition there is a tremendous amount of litter that effectively keeps the seed from reaching the mineral soil and precludes all chance of reproduction. Cultivating the soil with the advent of a logging operation seems to be the only method by which natural reproduction has been obtained. In that case, the 10% left has had no more influence in the reproduction than the 90% that was logged. The seed was produced by the entire stand and was on the ground at the time of the lumbering.

Ten sections of the Minnesota National Forest were not included in the timber sale and have been set aside to be maintained on a sustained annual or periodical yield basis. The cutover area produced 500 million B. F. which have been removed in the past 13 years. Had this area been handled on a

sustained annual or periodic yield basis the Forest would have been perpetuated and today we would not be worrying about the reforestation of 85,000 acres of land. In addition, there would have been a permanent industry in our midst drawn directly from the economic resources of the Forest. As it is, the business has moved to new fields.

Natural regeneration has proven unsuccessful, and it will be necessary to restock the area artificially. Planting is far more economical than the scattered seed trees, even if they had been a success in starting a new stand. Reforestation by planting falls under two lines of work, namely nursery operations and field planting.

NURSERY OPERATIONS

The Forest Service recognizes the value of reforestation work. White pine and norway pine, the two most important economic species, are represented in the nursery, because they have the highest market value. They are fairly rapid growing trees and combined with favorable soil, site and moisture conditions such as are found in Northern Minnesota make field planting a proposition that will bring a fair rate of interest on a long time investment. In 1913, a small ranger nursery existed at Cass Lake. At that time it was authorized at 200,000 capacity. In the same year it was enlarged and authorized at 500,000 capacity, with 300,000 white pines and 200,000 norway pines. Fifty per cent of the output is 2-1 stock, 20% 3-0 stock and 15% 1-1 and 2-0 respectively.

The nursery is located on National Forest land bordering the townsite of Cass Lake. The location is a particularly favorable one. In locating a nursery, the following factors are taken into consideration.

1. It should be located favorably in regard to the distribution of its products.
2. A well drained sandy loam soil is preferable.
3. It should be situated so as to escape frost and other injuries and should never be located in low, damp surroundings where it is highly susceptible to damping off.
4. An adequate water supply should be at hand.
5. Labor should be available at all times.

The Cass Lake Nursery has all of these peculiarly de-

sirable points except soil, which is for the most part sand and must be subjected to a building up process. It represents the one big factor with which the nurseryman has to contend. It is being overcome by the application of large quantities of well rotted manure that is stratified in manure receptacles. In addition, every square foot of available surface is sown to a cover crop, such as cow peas and rye. Commercial fertilizer applied directly to the beds during the growing season proved to be of great value in 1914. Because of the absence of a subsoil or even substrata, the plant food leaches away very quickly, but there can be no doubt that commercial fertilizer or immediately available plant food applied at the proper time and in the proper manner will stimulate plant growth.

The nursery is situated between two rather large bodies of water which, during times of low temperatures, prevent injuries from frost. Its close proximity to the town of Cass Lake eliminates the labor question and no mess or bunk house is required. The stock may be distributed either by rail or water. The freight or express depot is only one-half mile from the nursery, while a three-quarter mile haul will place the young trees at the dock. The latter combined with a government owned motor boat and barge affords a low distribution cost.

A pressure system supplies the water which is pumped into a tank installed on the top of a tower 30 feet high. The nursery proper, upon the installation of the water system, was divided into 100 foot squares and at the center of each a hydrant was erected.

Few nurseries have advantages such as this one. In fact, the writer does not believe there is another nursery in the United States where the supply and demand is entirely taken care of by the local forest. The seed is obtained from the Minnesota National Forest area. Everything necessary in nursery operations is obtained from the Forest and all of the stock raised is planted back on it, so it may be truthfully said that the Cass Lake Nursery exists through and for the Minnesota National Forest. Even the moss—such an essential factor

which is hard to procure for some of our nurseries—is found in great abundance not forty rods from the nursery site.

SEEDLINGS

Nursery work does not differ materially from many other agricultural pursuits. It is only a few steps in advance toward what we might call intensive farming. With that idea in mind, the ground is worked both fall and spring and placed in a mellow, friable condition. The beds are laid off 4′x12′ over which a seed bed cage is placed. Two foot paths are left between the beds while at regular intervals 4′ paths are left. This is done to facilitate the work of watering and cleaning up.

Equal amounts of seed are sown both fall and spring. One half of the beds are sown broadcast and the other half drilled. In drilling, the beds are prepared the same as for broadcasting. They are then marked off into drills 4″ apart. A board 4′ long and 2′ wide, with six V shaped markers is used in making the drill. By exerting pressure on it, the drills are made ¼″ deep. The quickest and most economical method of drilling seed is to take an empty shot gun shell and cut it off until it holds the amount required for sowing one half row. It is easier to work around the bed and sow one half row at a time. The cost of drilling exceeds that of broadcasting but it is not excessive. The beds are sown with the idea of growing 100 seedlings per square foot. It has been demonstrated conclusively that the beds have been overcrowded with the result that the seedling stock, whether used for transplanting or field planting was small, spindling and lacking in general appearance and suffered enormous losses, One hundred seedlings per square foot allows sufficient root and growing space and produces, stocky, sturdy plants that are able to withstand the shock of transplanting or field planting.

The one great danger, especially with norway pine, is the damping-off fungus. Each year we have suffered great losses. No practice, such as the manipulation of shade frames or the application of sand, seems to check it. The Bureau of Plant Industry is now working on prophylactic measures to control the disease.

A comparison of spring and fall sown seed brings out the

fact that the seedlings in the norway pine fall-sown beds are a little larger but there is not such an appreciable difference as is seen in the white pine. The white pine seedlings are one-fourth larger in the fall sown beds and while the same amount of seed is sown per square foot there are many more seedlings probably 25% more than from spring sowing.

During the early part of the season, while the seed is still germinating the beds are watered daily. It is thought that frequent light waterings are more beneficial than flooding of the beds. At the end of the germination period the water is gradually reduced until at the end of the growing season, the beds are watered but once a week. The older class of seedling stock receives water but twice a week during the early part of the growing season and but once every ten days toward the end. More water is applied to this class of seedling stock but at no time are the beds in a flooded condition.

TRANSPLANTS

Transplanting requires very close supervision. Under poor management, the transplanting is done at a very high cost and in the majority of cases results in large losses of stock. These losses may be due either to subjecting the plants to the sun and wind or it may due to improper methods of placing the plants in the transplant bed, or a combination of the two. The personnel of the transplant crew may vary according to conditions and methods, but on the whole it has been found that the trencher method is the most satisfactory and has produced the best results at lowest expense and with less loss of stock. The transplanting crew as used here consists of seven men, namely: one trencher, two tampers and four threaders. Two crews are worked under the supervision of one man.

Five or six beds are laid out and worked as a unit, carrying forward a continuous front. Each threading table is provided with at least three planting boards. The boards are constructed so that the plants are spaced 1½" apart and in rows six inches apart. The threading table is covered with canvas, only one side remaining open allowing men freedom for work. It was found in using 2-0 stock that two men at

a threading table are more than enough to form a well balanced crew. There is always a little time intervening between boards so that in using 2-0 stock of good quality, three men at two tables, the odd man alternating between tables, will be the most economical crew. The small 1-0 stock requires two men at each threading table to keep the tampers busy. The soil on the newly made beds is raked down at the close of each day and flooded to firm it about the roots and thus eliminate air pockets and the consequent drying of the roots and loss of plants. Previous to transplanting the soil should be wetted down so that the trencher leaves the trench in good condition for the plants. Trench slits must be left perpendicular since small ''cave-ins'' of dry soil will keep plants from being properly transplanted.

Transplants as a rule, depending upon the nature and the texture of the soil, require an application of water at least every ten days during the early part of the growing season. Light sprinklings while beneficial do not fill the needs, a thorough soaking and even at times a flooded condition seems to bring the best results. Cultivating aside from hand weeding should be avoided as much as possible. Mechanical cultivation, unless accomplished in a very conservative and careful manner results in great destruction of young trees. Transplants must be spaced as closely as is compatible with growing conditions. Mechanical cultivation is very apt to sever lateral roots which results in dead, weak or spindling plants that have to be culled before being planted in the field. Transplants, while not so exacting as seedlings in regard to soil and moisture conditions must have for the very best results a soil that is rich and well drained. Every effort should be put forth to bring the soil up to the condition necessary for seedlings.

FIELD PLANTING

The stock is dug with a spade and placed in the packing box with the roots to the center. A small amount of soil is left on the roots which are securely packed in sphagnum moss. When the packing boxes are filled, they are placed in a cool, damp situation to await their immediate distribution to the field. The cost of digging and packing transplants and

seedlings amounts to $.39 and $.13 per M respectively. This cost could be materially lessened by the use of some mechanical device such the the Smith tree digger now in use at the Halsey Nursery.

The planting area on the Minnesota National Forest represents two types of soil—clayey loam and sand. These respectively represent white pine and norway pine situations. These sites are again divided into three different planting areas representing burned and cutover land. Some of the area is very open with very little ground cover. This condition signifies a hard burn. Other portions of the area are similar but in many places a dense growth of grass and low bushes has sprung up, while other parts of the area are entirely brush land.

These situations represent individual problems which must be solved by constant attention and a diversity of planting stock. It would seem that the open, barren soil, where there is no competition with grass or other undergrowth would afford an ideal planting site. Certain classes of stock, the older and hardier, do survive on such sites, but the smaller classes cannot live unless they are planted during a year when the precipitation is above normal and comes at the proper time. The roots of the smaller classes, such as the 1-1 are very short, compact and well developed but they do not penetrate the ground to a sufficient depth to survive a drought. This same stock with the same seasonal conditions planted in the brushy type or on the shady side of a log or stump does very well. Observations have proven that the smaller stock during the fore part of the growing season will appear healthy and produce strong growing shoots but upon the advent of a drought during midsummer, the survival percentage will materially decrease. The matted sod and low bush type is the most difficult with which we have to contend. None of the stock seems to be able to cope successfully with it. It is necessary, in extreme cases, to remove a certain portion of the sod in the immediate vicinity of the plant. This is done with a spade, but in cases where the country is open and there are few stumps, or old windfalls, logs or other debris that may be left on the ground at the

completion of a logging operation, it is advisable to plow a furrow and plant in it.

The slit method is used in planting which requires a crew of two spaders and one planter. The spader opens the slit, the planter puts in the tree and the spader completes the operation by inserting the spade and forcing the soil against the tree. The soil is then firmly pressed around the tree by tamping with the foot. Five of these crews work together and form a solid front under the supervision of one man or crew foreman who constantly walks back and forth behind the line to see that plants are set properly. The stock is wrapped in moss and burlap and carried under the arm. A thousand trees per man per day is an average day's work.

Some apprehension was felt as to whether the slit method would prove practical in the clay loam soil. It was found that by planting before the frost was out of the ground the work progresses even faster than in the sand.

The work of reforestation on the Minnesota National Forest has been firmly established. There is no doubt about the practicability of it, nor the success of the plantations already made, and it is only a question of time before the entire area will be covered with a tree growth that will be perpetuated.

If the twenty-five million posts required each year for Iowa fence-posts were set in one line and spaced a rod apart, they would build a fence three times around the earth at the equator. Their cost is nearly four million dollars.

A clearing house for fence-posts has been established by the Forestry Department at Iowa State College for the benefit of the farmers. "Many farmers in Iowa want to buy native grown fence-posts, but do not know where to buy them", says Prof. G. B. MacDonald. "Other farmers have fence-posts to sell, but do not know where to sell them". Several carloads of Osage Orange posts have been listed.

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Credit for the financial success of this publication is due in a large measure to the patrons.

G. B. MAC DONALD

To
G. B. MacDonald,
who thru his intense
interest in better forestry, has made the course at Iowa State College what it now is, and who thru his earnestness and kindliness, has won the esteem of all who know him, we, the Forestry Club, respectfully dedicate this publication.

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The Philippine Forests

M. L. MERRITT, B. S. F.
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Unlike the forests of a temperate region, where in a single locality the number of tree species usually does not exceed 10 or a score, those of the Philippine Islands, and probably of any tropical country, contain a bewildering number and variety. In one locality where an actual count was made, 80 different species were collected on a single acre. While this is likely extreme, almost any acre in a virgin stand would probably contain a score of different kinds. Altogether it is estimated that there are more than 2,500 different tree species in the Islands. Many of these, however, are not large growing sorts. As a matter of fact, probably not more than 600 or 700 reach saw timber size when mature. Of those, only something over 100 different species commonly find their way into the markets as lumber.

It is popularly supposed also among those not familiar with the situation that tropical forests are made up principally of species producing cabinet woods, such as mahogany, rosewood, etc. While such kinds occur frequently, they very seldom constitute the bulk of the stand. In fact the real timber wealth of the Islands lies not in cabinet woods but in ordinary construction timbers, the great majority of which belong to a single botanical family—*dipterocarpaceae*. The dipterocarps, as they have been called, are as important to the Philippines from a timber standpoint as are the conifers to the United States. There are many different kinds of them represented in the family, probably as many or more as there are conifers in this country. Some produce hard durable woods while others are soft and easily worked. Many of them take an excellent finish so that when stained they are splendid cabinet woods. Practically all are large growing kinds, reaching heights of 130 to 190 feet and diameters of 40 to 60 inches, frequently much more. As a class they have straight regular boles often free of limbs for 100 feet. It can thus be seen that although botanically exceedingly complex, the forests from a commercial standpoint are not quite so confusing as would at first appear. In fact, when one has learned to recognize the dipterocarps in the woods, together with a number of other principal commercial species, it is surprising to know how large a per cent of the trees in a virgin forest are familiar to him.

A better idea of the general composition of the forests in general is afforded by a concrete illustration. On the Island of Mindoro, where the writer spent over two years, there were collected 552 different species. Of these, approximately 49%

reached when mature a diameter of 12 inches and a height of 40 feet or more; 32% were smaller than the above but over eight inches in diameter and 26 feet in height. The remaining 19% were smaller than the above although still with distinct tree forms. Of the total 552 species but 13 were dipterocarps. Undoubtedly this represents less than one-half the total number of species on the Island, but probably the proportions of different sized trees that occur is representative.

Before describing the forests further the following general facts are given concerning the Islands, so as to make clearer one's understanding of the situation. The Philippines lie between 5 and 21 degrees north latitude, about directly south of the east coast of China. The group consists of 11 large and about 2,000 small islands. All of the large islands, and many of the small ones, are mountainous with ranges generally extending in northerly and southerly directions. These commonly reach elevations of 3,000 feet or more above sea level, the highest points being over 10,000 feet.

Aside from the continuous warm weather, the outstanding climatic feature so far as its effect on vegetation is concerned is rainfall. The distribution of this is governed mostly by the direction of the prevailing winds, or the monsoons as they are called. From November to May the prevailing winds are from the northeast, during which period most of the rainfall is on the eastern or Pacific side of the islands. During this time the western portion of the territory, which comprises the greater bulk of the area and supports the largest part of the population, has a dry season. During the other monsoon the moist southwest winds striking the western coasts bring the wet season. The rainfall varies greatly from place to place, depending upon the effect of mountain ranges and other factors, ranging from 36 to 160 inches. Generally the precipitation is between 60 and 90 inches, most of which falls during the wet season between June and October.

The population is confined mostly to the sea coasts and to a few of the larger valleys, there being few people back in the mountainous areas where the virgin forests occur. Those living in such regions are practically all of the non-Christian tribes, the coastal population belonging to different so-called Christian tribes. In the zone between the settlements and the virgin forests are frequently large areas of grassland or of second growth timber, practically all of which represent areas that were once in forest but which have been cleared and cultivated and then abandoned.

The following tabulated statement gives approximately the area of land by classes:

Class of vegetation	Area in square miles	Per cent
Virgin forest	40,000	33 1-3
Second growth forest	20,000	16 2-3
Grassland	48,000	40
Cultivated land	12,000	10
Total	120,000	100

Native village, showing arrangement and construction of houses. The polins in center are young cocoanuts.

Native canoes or "bancas" as they are called. These are fitted with outriggers to prevent their upsetting.

Of the cultivated land probably not over one-half is cultivated during any single year. Of the grassland the larger percentage of area is not being utilized for any purpose.

Practically all of the timbered area of the Islands, both virgin and second growth forests, are still in public ownership and as such are under the direction and management of the Philippine Bureau of Forestry. The virgin forests are of chief interest since they contain practically all of the present stand of commercial timber. There are several more or less distinct types occurring in approximately the following proportions and containing about the quantities of timber shown in the following tabulated statement:

Type	Estimated area			Estimated volume of standing timber (million board feet)
	Per cent	Square miles	Acres	
Dipterocarp	75	30,000	19,200,000	192,000
Molave	10	4,000	2,560,000	7,680
Pine	5	2,000	1,280,000	2,560
Mangrove	2	800	512,000	1,024
Mossy	8	3,200	2,048,000	Protective
Total	100	40,000	25,600,000	203,264

As already stated, the dipterocarps are the predominating tree species. The forests in which they occur have been called the dipterocarp type. In this type are many sub-types, depending on composition which in turn is determined by the various factors of the environment. In general, however, the dipterocarp forest occupies the regions where growing conditions are most favorable. These vary topographically from moist river bottoms to hilly and mountainous country. In composition the dipterocarp type generally is very complex. First are the large dominant trees, among which various species of dipterocarps are generally most common. There are, however, a great variety of other large growing sorts which add to the complexity of the forest, but many of which kinds have never yet been utilized commercially and some of which have little apparent value. Under this upper story of dominant trees, which often does not occupy the entire area, is an understory of small sub-dominant ones of great variety but generally of minor importance from a commercial standpoint. Still below the sub-dominant trees are the smaller kinds of tree species and a heavy growth of herbs and shrubs. Although these latter always grow in the greatest profusion as compared with forests in temperate regions, they are relatively fewer where the stand of timber is dense. Over and through the whole mass of trees, shrubs and herbs is almost invariably a tangle of vines. Always present as a major element in their composition are several species of climbing palms or rattans, some of which produce the rattans of commerce. Although the diameter of these rattans is small, varying from one-half to 2 inches, they grow to great length,

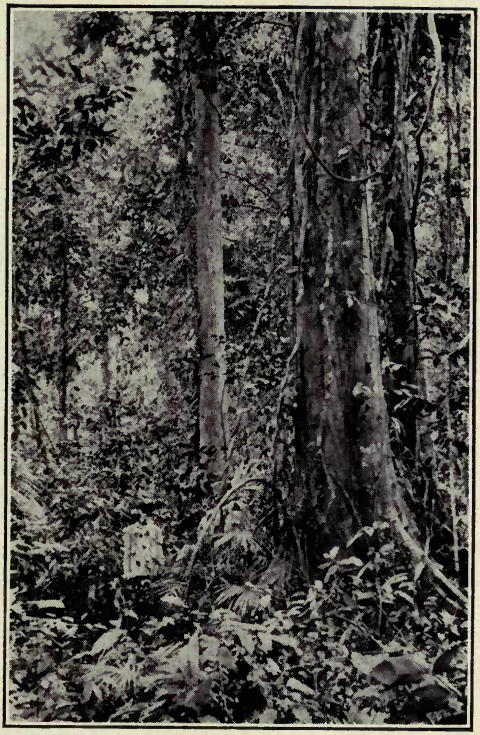
probably 300 or 400 yards or more. At any rate they reach to the tops of the highest trees and make tangles of growth in the openings that are almost impenetrable. Their long palm-like leaves are armed with strong recurved spines which if caught in one's clothing will bring you to a sudden halt. In many places also climbing bamboo occurs in the openings and forms an even more impenetrable mass than do the rattans.

The quantity of timber per acre varies, of course, with the site and the composition of the forest. The following tabulated statement, based on averages of different tracts that have been examined in different localities, will give an idea of the quantity of timber in trees over 16 inches in diameter that occur in a number of localities:

	Feet B. M. per acre
Northern Negros (Low hill forest)	
Dipterocarps (6 species)	42,900
All other species	2,300
Total	45,200
Eastern Mindoro (River Plain)	
Dipterocarps (4 species)	9,400
All other species	6,900
Total	16,300
Mindanao Island	
Dipterocarps (10 species)	13,600
All other species	15,300
Total	28,900
Bataan Province (Hilly to mountainous)	
Dipterocarps (6 species)	19,600
All other species	8,900
Total	28,500

The molave type is so called because molave (*vitex parviflora*), one of the hardest and most durable woods which the Islands produce, is a characteristic tree. This type occupies the drier sites, generally the lower hills where growing conditions are not so favorable for the development of heavy stands of dipterocarps. The forest is much more open than in the previous type and the larger trees are farther apart, shorter and more irregular in form although some of them are among the most valuable species which occur. Between the larger trees is the characteristic understory of smaller ones and through the whole a profusion of vines in which the climbing bamboos often predominate. The stand per acre in this type of timber is small as compared with the previous one, averaging not more than 3,000 feet B. M. per acre with maximum stands perhaps 3 or 4 times as large. The commercial value of this type, however, is greater than would at first appear, since many of the trees are splendid cabinet woods which bring the highest market prices and also because this type of forest is apt to grow in the more accessible regions so that the cost of exploitation is relatively low.

The mangrove type grows on tide flats, at the mouths of streams and on the shores of protected bays, in fact practically



Interior of virgin dipterocarp forest. The large trees are dipterocarps. Note the man in the foreground almost obscured by the mass of herbs and shrubs.

everywhere that tide water covers the land except on exposed beaches. Frequently these tide flats are a mile or more in width. In composition these forests are very simple, the majority of the stand belonging to a single family—*rhizophoraceae*. Frequently some of the different species occur in pure stands, although generally there are a half dozen or so mixed together. Nearly all of them are relatively small growing kinds in normal mature stands ranging from 6 inches to 30 inches in diameter and from 40 to 50 feet in height. There is relatively little undergrowth except near the upper limits of tidewater where this type mingles with fresh water ones. These mangrove swamp forests produce great quantities of fire wood, while the bark of many species is gathered as tan bark. In addition to the trees described above, a palm known locally as "nipa" grows along streams in many parts of the tide flats. The leaves of the nipa palm are one of the most important products of the Islands to the natives, since they are used almost exclusively for thatching roofs and sides of the native houses.

The beach type of forest grows on sandy beaches and beach flats lying above high water. The stand is very complex, containing a great many species, but the type is not especially valuable.

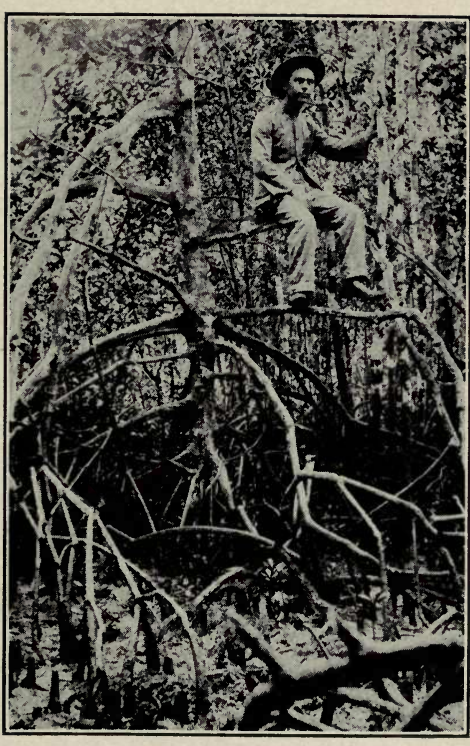
The pine type of forest occupies the high mountainous region of northern Luzon, nearly all of which is over 3,000 feet in elevation. Throughout this region pine (*pinus insularis*) grows in nearly pure stands. Occasionally these are dense, running up to 10,000 or 20,000 feet per acre, but more often they are very open and scattered. In the pure stands of pine there is very little undergrowth except grass and ferns. Strange to say, the common fern growing in this region belongs to the same genus as does the brake fern so common in portions of the United States. In the stream bottoms and on the moister slopes broad-leaved species occur, often forming dense jungles not unlike that in other forest types. In general appearance the open pine forests are not greatly different from the yellow pine forests in the western United States. The trees grow to large size and produce a fair grade of timber which is rather inclined to be pitchy. This type of forest is practically the only one which is liable to be killed by forest fires. The grass, which during the wet season grows in great profusion, dries out in the dry part of the year and with the needles that have accumulated, burns fiercely, doing great damage to reproduction and often to mature trees. Apparently it is the forest fires that have prevented the pine from producing dense stands. With fire protection the region would probably support a fairly uniform and heavy stand of timber, possibly 15,000 or 20,000 feet B. M. per acre. Scattered pine trees are also found in two other localities aside from the mountainous area of northern Luzon—one in

Zambales and the other on Mindoro Island. In both of these latter areas there is also another species of pine found in addition to the one growing farther north.

The mossy type of forest, or the mountain type, as it might be called, is a purely noncommercial one, occupying the higher mountain tops all over the Islands. Most of the trees are small in size, although there is still a dominant and sub-dominant story. There are, however, fewer vines although still a large amount of undergrowth. The outstanding feature of the forest is the ever present covering of moss. This grows on all the branches and trunks of trees and shrubs, so that stems an inch or 2 inches in diameter are often so covered with moss that they appear to be 5 or 6 inches in diameter or more. Sometimes the moss hangs in long tendrils from the branches and in turn is covered with ferns and orchids, so that taken as a whole this type of timber is by far the most beautiful of any on the Islands. Among the tree species which occur are species of ash, maple, yew, barberry, oaks and several other temperate zone species. In the herbaceous growth also are a great many familiar plants in which are a number of species of violets and a wild rose. Here also ferns develop into definite tree forms which are found nowhere else.

In the foregoing discussion little mention has been made of palm trees. There are a great many different species of these which are very numerous in some localities, especially in the dipterocarp type of timber. Usually they occur scattered with the other trees, although in a few instances in pure stands on areas of a few acres each. As a whole, however, palms constitute a minor part of the forest.

The above discussion gives a general idea of the composition of the forests themselves, and now a word regarding some of the commoner animals which are found in it. Just as favorable growing conditions produce a profusion of vegetation, so does the favorable climate often develop an abundant fauna. Among the larger animals are wild pigs, deer, wild buffalo and occasionally monkeys. The former are widely distributed and in places are very numerous. It is very usual to see them scurrying out of the way as one comes near. They are of the razor-back type, sometimes reaching 200 or 300 pounds each in weight. They live on fruit and vegetables found in the forest and afford very excellent meat. Deer are not so widely distributed as are pigs, but are numerous in the more open places and especially in grassy areas away from settlements. There are several species—all good food. Wild buffalo (*carabao*), while not widely distributed, roam in large herds in a few of the unsettled regions, especially along the flat plains of the larger rivers where quantities of natural forage is produced. These probably are not native but have developed from animals which have escaped from civiliza-



Mangrove swamp showing high stilt roots of one of Rhizophora.

tion. In Mindoro Island is a native buffalo (*tamarao*) found nowhere else. These animals are said by the natives to be very ferocious and to charge a man on sight. Although the writer has known of several instances where men were injured by them, he has never seen one alive, although several months were spent in the territory in which they are found and many of their trails were followed. Probably their ferocity is greatly exaggerated by the natives. Monkeys occur in groups in some regions, generally near settlements.

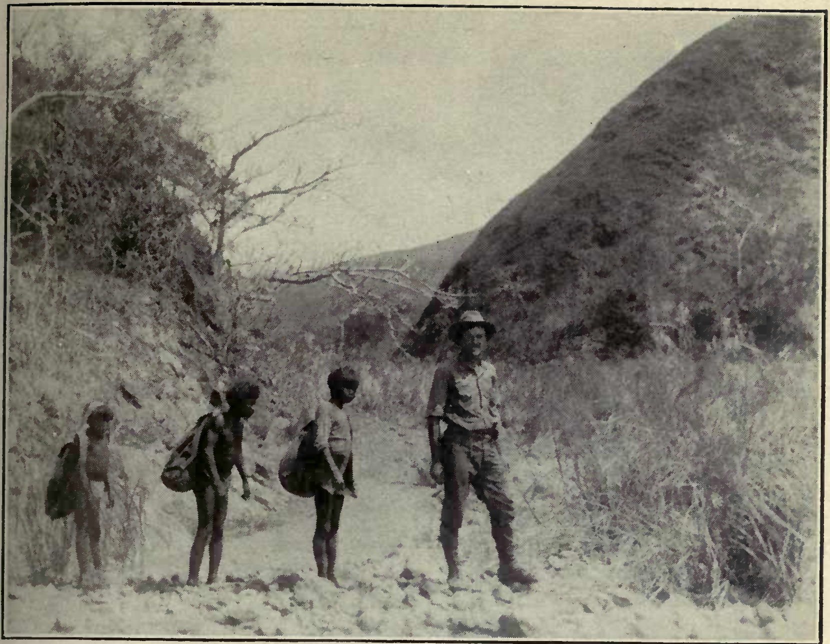
Bird life is abundant, although one is rather dsappointed that there are not more species with brilliant plumage. Among the different kinds are wild chickens which are found practically everywhere throughout the woods at the lower elevations. These chickens resemble the domestic game chickens that are raised in this country and are a food much prized by the natives.

Land travel throughout the Islands is slow and methods are very primitive. Most of it is done on foot, although in some places one can secure little native horses, which although not very much bigger than a man, are able to carry you along the sandy beaches or trails through the woods with apparent ease. The sandy beaches are the commonest route of travel in the less settled regions, being the main thoroughfares between the scattered villages which are all located on the seashore. Outside of Manila and a very few of the larger towns, there are no hotels whatever, so that one always stops at private houses unless in the woods. The people, however, are very hospitable and often inconvenience themselves greatly to care for visitors.

For food rice is everywhere the staple, potatoes and flour being very seldom obtainable. For meats fish is most often used, the natives drying fish and taking it with them on trips, or keeping it for a reserve supply. In villages chickens and eggs can generally be had. Bananas are found in most places during practically all seasons of the year, but other fruits are not common except for relatively short seasons. In addition to these and a few other articles which one can secure from the natives, an American traveling in the Islands generally takes with him a supply of canned goods.

These are a few of the conditions which an American forester meets in the Islands. At best life is hard. One could recount obstacles and difficulties almost without end. There is the possibility of sickness away from medical attention and in a country where disease develops rapidly. The torrential rains frequently swell small streams to the size of rivers and makes fording them dangerous. Similarly, the tides raise the water in small streams which at low tide are fordable, so that one can only sit and wait for the water to go down. Often the American forester has to spend weeks or months away from his fellow white man, sometimes away from mail communication. But with all its drawbacks,

the life is most fascinating and interesting. In few places is such an opportunity offered one to explore, map and describe unknown regions. Everywhere are strange trees, new plants and unusual surroundings. The extremely favorable growing conditions and the large variety of plant life afford one an opportunity to study ecology which is unexcelled, and the mere living among a different race and associating with them, as must a forester traveling through their country, cannot help but give him a broader grasp of their life problems and more sympathy with those who happen to be born into a less favorable environment than our own.



My outfit on a field trip. The two larger natives are full grown, being representatives of one of the mountain tribes—the Mangyans.

Windswept trees at summit of highest mountains.

Seed Vitality as a Factor in Determining Forest Types

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How many people, including foresters, when expressing admiration of a tree, ever think of the adverse conditions which that tree has had to overcome in order to attain its present graceful or magnificent form? These adverse factors are met in artificial reforestation yet the forester is able to establish thrifty forests where nature has failed. This success is accomplished by the use of methods which nature cannot supply, such as planting a tree two or three years old, thereby eliminating all the factors which mean failure during the seedling stage. Thus it is within the realm of the forester to improve on nature's methods in tree production the same as this end has been accomplished in many other activities of man. Just as in the natural state, the eggs of the shad fish produce about 2 fish out of every possible million while man has insured a success of 70%, so is nature producing millions of tree seeds where a very small per cent or none produce trees. It is the endeavor of this article to give some of the reasons for nature's apparent wasteful methods and to show how these facts, when known, may be utilized by the forester.

The limitations of forest types as the forest gradually or abruptly gives way to prairie, or the clearly drawn lines along ridges where one type occupies the north and east slopes and another the south and west, or the definitely drawn lines within the forest have been the subject of much discussion and conjecture. At the present time soil temperature and soil moisture are conceded to be the controlling factors in these limitations of species. While these no doubt are very important and influential factors the seed and its characteristics, of the species concerned, must not be overlooked, because, after all, the controlling unit of any species is the ability of its seed to perpetuate the species.

The presence of any species on an area is prima facie evidence of the 4 principal chapters in the establishment of a forest, viz:

Seed production.
Seed distribution.
Seed germinability.
Seedling establishment.

Since these stages are distinct and consecutive they may best be considered consecutively.

SEED PRODUCTION.

The production of seed in any type has not been found to be a limiting factor in determining type except in very special and extraordinary cases. Any forest type produces sufficient quantities of seed and at short enough intervals to insure a perpetuation of the type providing other factors are favorable. The variations of seed production may, however, have some bearing on limitations of species. Some species, such as hemlock and cedar, produce almost annual crops of seed and thereby provide a constant supply of seed and are ready to take advantage of all favorable seasons for establishment while species producing seed at more or less periodical intervals, as western white pine, Douglas fir, and others may miss favorable seasons of establishment through a lack of seed.

SEED DISTRIBUTION.

The distribution of forest tree seeds depends to a great extent on the local conditions, such as topography, wind, rodents, etc.; and perhaps even to a greater degree on the nature of the seed itself. Heavy seeds as western yellow pine and western white pine are usually carried only a short distance by wind, seldom exceeding 5 to 6 chains, while lighter seeds as western red cedar and western hemlock may be carried farther.

Where the forest type changes abruptly from a Douglas fir-cedar-hemlock type on the north and east slopes to a yellow pine type on the south and west slopes, as occurs in Idaho and Oregon, the determining factor very clearly is not seed distribution. The location of seed-bearing trees of all these species would insure seed of all species being distributed over large parts of the areas covered by very distinct types, yet some of the species do not appear at all in the stand although the presence of seed is assured.

SEED GERMINABILITY.

The foregoing discussion has shown that the presence of seed alone on an area does not insure the appearance of the species nor does this factor alone determine type limitations, however, in this same connection the germinability of the seed is important. When white pine, Douglas fir, hemlock, yellow pine and cedar are in competition the seed of each species may be present at the same time, but the varying periods required for germination, under favorable conditions, give the advantage to the species which germinate quickly, such as hemlock and cedar and may result in the suppression of the dilatory Douglas fir and white pine. In some instances the disadvantages of delayed germination are offset by the ability to overcome competition by faster growth during establishment. This character has enabled the white pine and Douglas fir to be successful competitors of hemlock and cedar on sites favorable to all of these species. The

short period required for germination of yellow pine when conditions are favorable is its greatest asset in gaining possession of severe sites or maintaining itself on such sites. If in the spring there is a period of favorable moisture and temperature for 2 or 3 weeks such species as are able to respond quickly to those conditions are the ones which have a fair chance for success, because such conditions may not be duplicated again throughout the season and the species which germinate slowly may be only beginning to respond when the favorable period closes. Hence the inherent germination characteristics of tree seeds have an important bearing on the limitations of the species.

SEEDLING ESTABLISHMENT.

Establishment involves the ability of the seedling concerned to take advantage of the favorable periods of soil moisture, soil temperature and light. First of all, as shown above, the seed must germinate quickly when the favorable conditions obtain in order to gain its greatest possible development before the adverse conditions overtake it. A favorable period of 6 weeks may suffice to germinate and establish a seedling when the seed germinates in 10 days or 2 weeks, but one which requires 4 to 6 weeks to germinate will have developed just far enough to be the victim of the first unfavorable period of drought or temperature. The surface soil often dries out quickly on exposed sites and the seedling with only a short radicle is soon caught by such dry periods, while the seedling which produces a deep root early in its development can resist such short unfavorable periods. This is a fundamental principle which often determines the success or failure of a species. The size of the seed is the important factor because on the stored food in the endosperm depends the early rapid development of the plant. These points are graphically shown in plates 1-5. It is these facts which give the yellow pine the advantage over the hemlock and its associates on the severe sites in the forests of western Montana and Idaho. For the same reasons the Douglas fir is able to establish itself on the drier slopes of the Cascades, while the cedar and hemlock fail. A south slope covered with yellow pine or Douglas fir and a north slope covered with hemlock, white pine, cedar and other species does not necessarily mean that each of these species is in its optimum habitat, but that these are instances of competition and establishment. The yellow pine would produce even a better forest on some of the slopes occupied by the other species if it could established itself there, but conditions unfavorable to its establishment prohibit its presence. Its development on such sites is shown by the magnificent single yellow pine trees found among the north and east slope types. On the other hand the hemlock and cedar do very well under the conditions of the south slope wherever they can get conditions favorable

to their establishment. The reason these species are not mixed all through the forest is not due to the lack of seeding or even to the germination of the seed on the different slopes. This point is emphasized where these types meet on a ridge. The south slope is seeded with the seed of the species found on the north slope and the seeds of the hemlock, cedar and Douglas fir, as well as the yellow pine, germinate in the spring but the seedlings with only shallow roots cannot resist the period of summer drought and in the fall only yellow pine seedlings remain. These conditions are repeated year after year and still the type remains the same. It is very noticeable that wherever conditions favorable to establishment have obtained on the south slopes the north slope species are found, sometimes in very unexpected localities.

When the seedlings or trees of a species are found on any site it shows that that particular site is favorable to the species found there, but it does not prove that any other species would not establish itself there or develop on the site if given a chance. Sometimes it is merely a question of which species happens to get possession of the area after the forest was removed, or which species first had the opportunity of migrating there, while in other instances it is clearly a matter of competition or ability to withstand the conditions of the site involved.

Species are, in general, rather impartial in regard to soil if we except chemical and physical extremes (abundance of common salt, lime, or of water) and if they have no competitors. In the middle of its distributional area a species makes no selection as to soil, but outside this central position it is forced by other species to exercise a choice. Nearly all species are facultative and their occurrence depends upon competitors. If these be present the one drives back the other and the victorious species is the one which can best utilize the given combination of soil, light, moisture, temperature, etc., during its period of germination and establishment.

Where forests of one species are sharply delimited from forests of other species it is not a question of inability to thrive at the boundaries but rather a question of what use the species can make of the favorable periods during establishment. In many instances a species will succeed and develop as well or better far beyond its natural range if assisted artificially during its seedling period. While these facts have been recognized in reforestation the failure of nature to accomplish the results has been attributed to factors other than seed viability and vitality. The importance of physical factors must not be minimized in considering limitations of type but the most important factor in local limitations, the seed and its characteristics, has not been considered in the past.

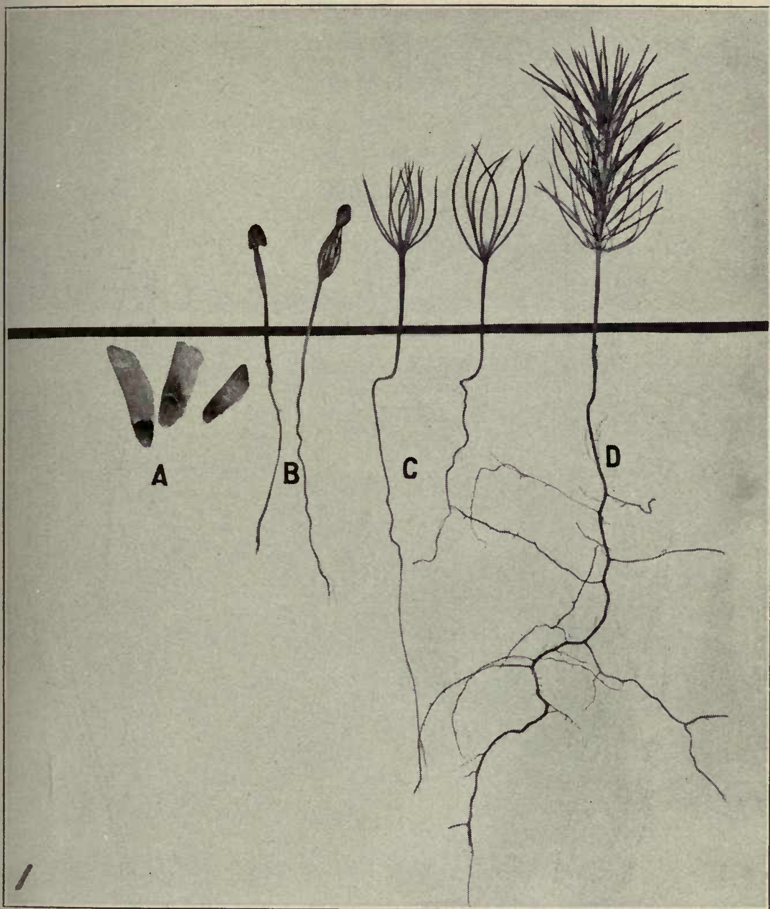

Plate 1. Three-fifths natural size. Western yellow pine (Pinus ponderosa).
A. Seed with wings.
B. Seedling before seed coat is dropped.
C. Seedling with cotyledons—note length of radicle.
D. Seedling one year old—note well-developed root system.

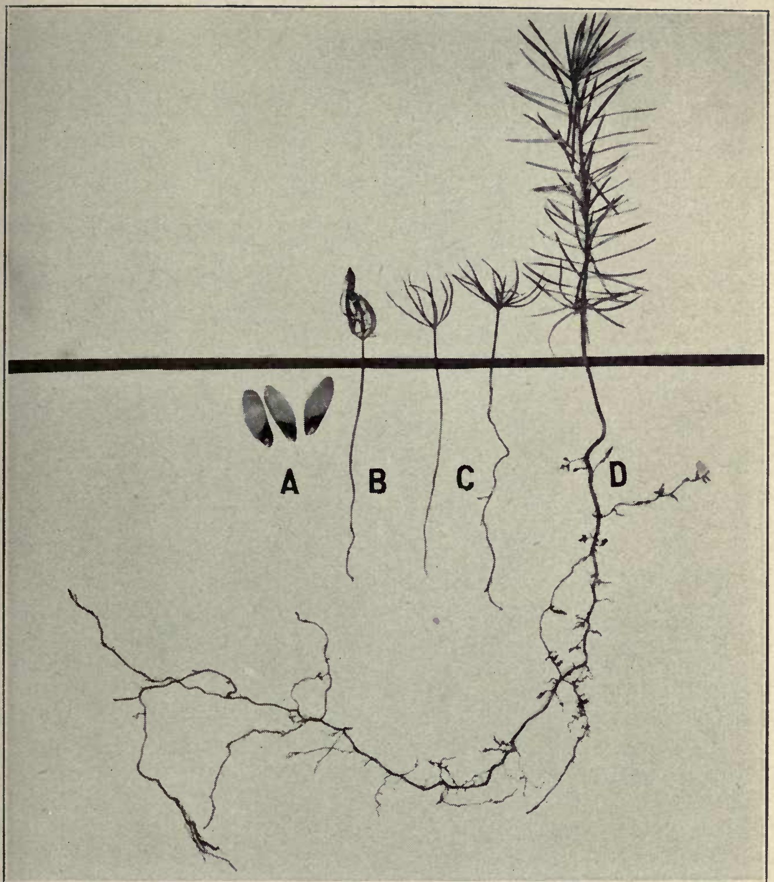

Plate 3. Two-thirds natural size. Douglas fir (Pseudotsuga taxifolia).
A. Seeds with wings.
B. Seedling before seed coat is dropped.
C. Seedlings with cotyledons.
D. Seedling one year old—deep rooted.
The Douglas fir does not establish itself so early in its development as the white pine.

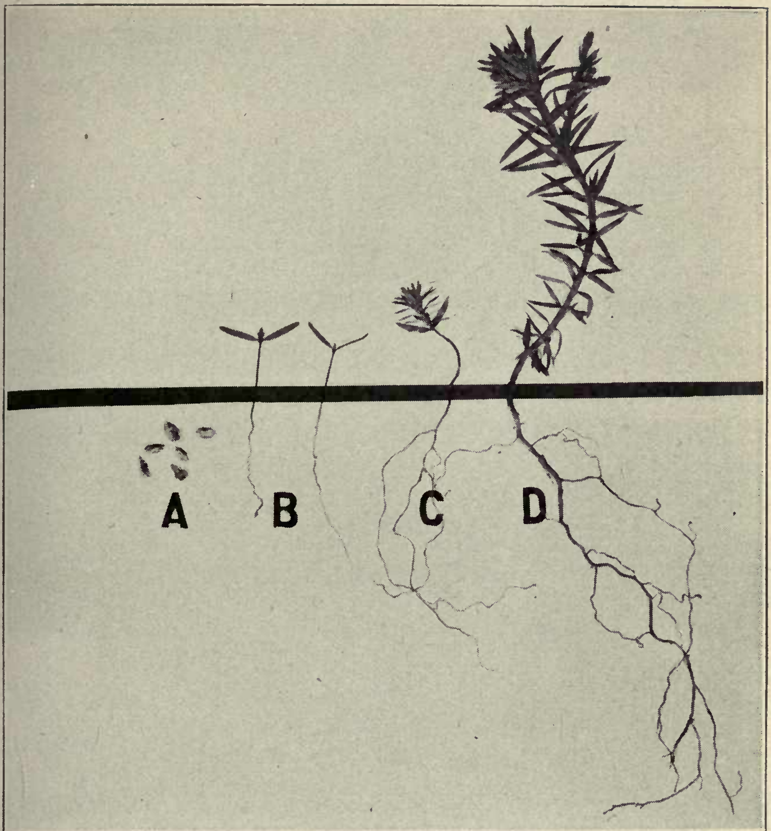

Plate 4. Five-sixths natural size. Western red cedar (Thuja plicata).
A. Seeds.
B. Seedling with cotyledon.
C. Seedling one year old.
D. Seedling three years old.
Note small seeds and seedlings. This species requires three favorable seasons in order to become established.

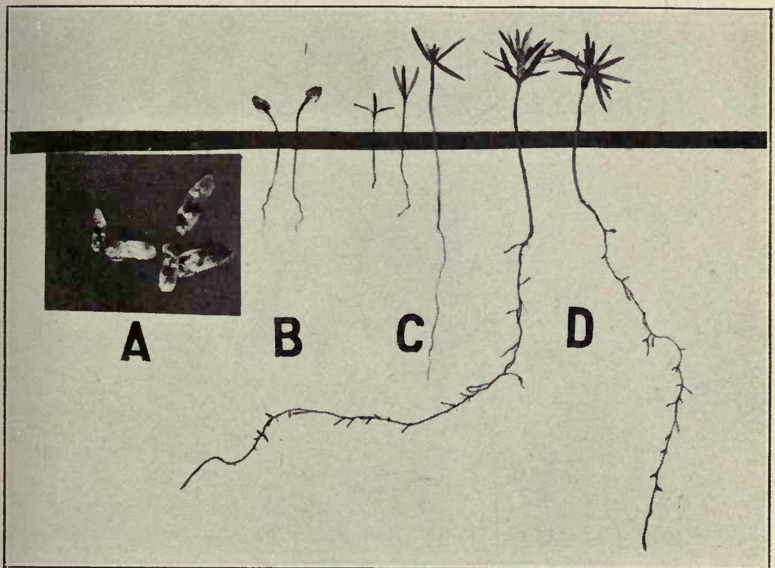

Plate 5. Seven-ninths natural size. Western hemlock (Tsuga heterophylla)

A. Seeds and wings.
B. Seedlings before seed coats are dropped.
C. Seedlings in cotyledon stage.
D. Seedlings one year old.

The size of the seeds and the small seedlings during the cotyledon stage and through the first season all show the favorable conditions the hemlock requires for establishment.

Utilization of Wood Waste

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Imagine if you can a slab fire which has been kept alive day and night almost continuously over a period of 55 years by the refuse from a single large sawmill. Try to realize that this is an actual mill operating in the redwood region of California and that it is only one of many mills of similar size. You can not then help wondering why so much potentially valuable material must be wasted.

In a country like this with its immense supplies of raw material and its relatively small population per unit area the answer is not easy. Distribution for fuel is prohibited by hauling costs. Smaller countries with fewer resources and more dense population, with highly specialized industries, with demands caused by a keener struggle for necessities and luxuries, have been driven to closer consideration of the question and have to a great extent solved it. For example, wood waste in the densely populated portions of Europe means sawdust, and not much of this relatively unimportant material is actually wasted. It finds use as fuel in natural form, in briquettes, and as gas resulting from distillation. In combination with binding and cementing substances such as glue, albumin, blood and resin it forms plastic materials, artificial wood and xylolith or woodstone. In cheap but often very durable linoleums it takes the place of cork, a more valuable tree product. Various processes of manufacture produce from sawdust oxalic acid, acetic acid, formalyn, tannin, dyes, grain alcohol, wood alcohol, oils, tar, charcoal, etc.

In the United States until quite recently wood waste has meant practically all of the wood produced by the forest which could not be converted into salable lumber and from such lumber into buildings, railroad cars, ties, vehicles, furniture, fixtures, barrels, boxes and so on down through the list to knobs for tea kettle lids and the dowels which are concealed in many larger wooden commodities. In terms of a tree the sum of these represents about one-third its volume. The other two-thirds constitute wood waste. Specifically, wood waste consists of stumps, tops, broken logs, inferior species and other material left in the woods, of sawdust, bark, slabs, edgings, trimmings, pooly sawn boards and lumber depreciated in seasoning, all incident to manufacture; of sawdust, shavings and blocks which do not find use when the lumber is remanufactured into things people need.

The refuse left in the woods is not only lost but becomes a menace to the remaining forest by harboring disease and insects and by serving as tinder which a stroke of lightning or

a careless camper, hunter or smoker may convert into a destructive fire. The refuse of a sawmill, except for the portion which can be used for fuel to drive the saws and other machinery, must be disposed of at the expense of the owner. A mill producing daily 100,000 feet board measure is not large as mills go, yet it is estimated that $10 is a fair average cost for destroying the waste from a day's cut. The total annual waste of all mills in the United States has been given as 36,000,000 cords or 4½ billion cubic feet, enough to make a solid cube one-fourth mile high. Naturally the intelligent, progressive lumberman desires very much to find a use for his waste raw material and considerable sums have been spent in experimentation looking toward means of accomplishing this.

Keen competition has reduced the profits on lumber until at times they have threatened to disappear entirely. Under these conditions the profits on by-products may play an important part in the advancement of wood-using industries now employing 10 per cent or over 1,000,000 of the country's wage earners, and having an annual output roughly valued at $2,000,000,000. The cutting of timber has progressed at three times the normal rate of growth and of the original 5,200 billion feet in our virgin forests, 2,300 billion feet have been removed. The danger of timber famine has been pointed out and has given rise to the widespread study of conservaton. This in turn has fostered utilization and we are on the way to doubling our forest resources by reducing waste. In 1914 the estimated wood waste used as pulpwood by our sawmills amounted to 330,000 cords valued at about $1,400,000. In the same year these mills consumed an estimated total of 4,290,000 cords valued at $36,800,000. The average cost per cord of wood delivered at mills of reporting concerns was $8.58; for wood waste only $4.25. The Forest Products Laboratory reports that one lumber company in the Lake States region claims the removal of 3 times the material from the forest and the employment of twice the number of men formerly employed in producing an equal amount of lumber. A progressive lumber company in Pennsylvania is securing from its waste a gross return of $124 per acre, or 34 per cent of the total gross return from its hemlock and hardwood logs.

Germany has accomplished more along the line of systematic development of forest resources than any other country. In the roll of honor the United States ranks second. No small part of this is due to the work done in the Forest Products Laboratory at Madison, Wisconsin, established in 1910 by the Forest Service of the Department of Agriculture in co-operation with the University of Wisconsin. Nowhere else in the world is there a laboratory of this kind so completely equipped. Its various sections specialize in investigations of the mechanical, physical and

chemical properties of woods, the value of various species for pulp and paper manufacture, the art of timber preservation to prolong its life, and the destructive agencies which cause decay and other kinds of depreciation. The drying of lumber by both natural and artificial means, testing of special preservatives and processes of preservation for individual species and for particular purposes, development of improved methods of pulp and paper manufacture and of wood distillation, and the practical application of results in the arts and industries are among its activities.

Sudden changes in commercial relations caused by the European war have given stimulus to numerous domestic industries. Some of these utilize forest products. Osage orange dye, produced from mill waste, has within the last year been developed as a substitute for fustic imported from Jamaica, Southern Mexico and Central America. Over $1,000,000 worth of this dye was produced in 1916 and osage orange has gained lasting commercial recognition as a dyewood.

Charcoal is used in the manufacture of black powders and in driving bullets from shrapnel. It is also indispensable in the production of certain high grade steels required for guns and armor plate. The nitrate fibres used in nitrocellulose powders must be treated with a solvent and acetone, made from acetic acid, a hardwood distillation product, is employed for this purpose. Without acetone, procured largely from this country, Great Britain could not produce the cordite used by her soldiers on the battlefield. In this connection it may be interesting to note that a study by the Laboratory experts of the operating methods in a destructive distillation plant resulted in one case in increased yields of products valued at $15,000 annually. Another investigation resulted in the use of spent tanbark in the manufacture of patent roofing to the extent of 160 tons per week. The value of the bark has thereby increased from 60 cents to $2.50 per ton. The tanning industry now handles over 1,000,000 cords of waste per year. Some of this will be used in making sheathing paper, carpet liners, bottle wrappers, deadening felts and similar articles for daily use.

Formaldehyde, the universal disinfectant, is manufactured on a commercial scale entirely from wood alcohol. It would be difficult to estimate how many human lives are saved by preventing the spread of contagious diseases with this effective enemy of the germ. The agriculturist finds a use for it in disinfecting seeds, thus assuring a greater food crop.

For 5 years the Laboratory has been working on the production of grain alcohol from wood. In this time the yield has been raised and the cost of production lowered. Waste material of coniferous species has been found to give higher yields than do hardwoods. Chemical analysis of certain woods, notably western larch, has shown them to be especially rich in a water

solution material, galactan, which, converted into fermentable sugars, constitutes raw material for grain alcohol. Larch sawdust, hydrolyzed under pressure with acids, yields sufficient sugar to produce 35 gallons to the ton. Spruce sawdust yields 25 gallons. Probably 40,000,000 gallons of denatured alcohol were used in the United States in 1916, and huge quantities were exported. Grain alcohol from wood is no longer a mere possibility; it is today being manufactured in a large plant located in the South and using mill waste of southern yellow pine. Thus Mark Twain's statement that the country would never go dry as long as every table leg was good for a jag seems to be verified. Nor is this all. Galactan in oxidation yields large quantities of muric acid, a substitute for tartaric acid in the manufatcure of baking powder, an industry in which large quantities of tartaric acid are employed. Hydrolyzed galactan becomes galactose, which, with the addition of a small amount of alkali and subjection to heat, is transformed into a fine sweet syrup.

Seven billion pounds of artificial silk made from wood are used annually in this country. This material goes into silk sweaters, hose, neckties, fancy braids and millinery. It is merely cellulose reduced chemically to a gelatinous substance known as viscose. Some of the tough sausage casings now in use are also made of viscose, and this substance will undoubtedly find a great many uses. In Germany, since cotton is no longer obtainable in sufficient quantities, soft, artificial cotton is made from wood cellulose for surgical purposes.

Another interesting field of research for the utilization of wood waste and one giving promise of unusually important commercial results has to do with the manufacture of kraft paper and its remanufacture into a great variety of products. Kraft is a very tough paper because the action of the chemical used for reducing the wood to pulp is not severe enough to seriously weaken the fibres. Its natural color is brown, but it can be dyed easily by adding color to the pulp. In the form of tough, heavy wrapping paper it enters every home. Longleaf pine, western yellow pine, sugar pine, redwood, white fir, red fir, and a number of other species yield excellent kraft. It is used for large envelopes, book covers, imitation leather, especially that employed in the furniture industry, cardboard and matting suit cases, etc., and if cost of leather continues to go up we may eventually wear wooden shoes made from specially prepared kraft. Like most papers it is usually made up in the form of wide sheets which are wound on cores into large rolls. These rolls are cut into long ribbons or strips of varying widths which are in turn fed into spinning machines for the production of yarns and reeds. Sometimes the paper is gummed and coated with cotton fleece before spinning and the yarn so produced is used in the manufacture of cheap towels and napkins. One

of the largest single uses of spun paper in the United States lies in the production of so-called fibre rugs. These may be made entirely of paper or of paper and cotton or wool. The total daily output of such rugs is probably in excess of 100 tons.

Paper furniture is now a common article of commerce and its use should increase greatly. The reeds are usually made from heavy paper, stiffened by various processes, and when woven over wooden frames and coated with shellac, they produce an excellent substitute for other reeds.

Rope and cord made from kraft alone or from kraft with a core of hemp or sisal are finding considerable favor. Cheapness, smoothness, uniform strength and size are the points in which they excel other cords. European manufacturers are producing clothesline, sash cord, driving reins, skipping ropes, web straps for surcingles, and a variety of articles from paper twine. Floor mattings, stair runners, imitation burlaps for wall coverings, tapestries, and bagging to replace jute are other products. Eventually paper yarn will be woven into cloth to be used in making cheap clothing for rough work. Binder twine from paper to replace that made from imported fibres is another possibility of economic importance in our industrial development. Insulating tubing for electric wires, both for use under ground and overhead, is made partly from paper, as is also pipe for carrying liquids.

As a means of reducing wood waste by bringing wood users together the Office of Industrial Investigations of the Forest Service has opened a wood waste exchange. The co-operators now number over 500, many of whom have reported successful purchases or sales of wood waste through the Exchange. Thus a man desiring blocks for brushes may find that he can obtain cheaply for this purpose material which in another industry is waste.

Forest products investigations covering comparatively few years have opened our eyes to the uses of today and the immense possibilities of the future. The consumption of forest products is increasing, and the degree to which wood waste contributes to these products is the degree by which we are approaching the very remote goal—complete utilization. As the value of the tree is increased closer application of correct forest management is made possible. With this comes the assurance of steady supply and the consequent development of wood-using industries.

The Stumpage Situation in the Pacific Northwest

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Standing timber is a natural resource which permits of fairly close measurement. The virgin supply in the country is strictly limited. Unlike other natural resources, such as minerals, gas and petroleum, the timber has all been located, and the total volume more or less accurately determined.

It is thought that the forests of the United States at the time of the country's discovery contained upwards of 5,200 billion board feet of timber. The latest reliable reports place the present stand at somewhat more than one-half the original estimate, or about 2,700 billion board feet. The commercially important stands in the eastern states have been largely cut over. Michigan, which for 3 decades held first place in lumber production, is now surpassed by a dozen states, none of which produced lumber in any quantity 25 years ago. The cut of white pine in this state is so small in recent years that no mention is made of the species in the government reports. When one recalls that only a few years ago Michigan was the leading state in the manufacture of pine lumber, the rapid disappearance of the forests is brought vividly to our minds.

There are still large tracts of timber in the southern states, but these are also being rapidly reduced through extensive exploitation.

The western states are now the great reservoirs of virgin timber in the country. About three-fifths of our entire supply is found in the states bordering the Pacific and in Idaho and Montana. The bulk of the stumpage is owned privately, and mostly in the form of large holdings. Small tracts are being acquired by the larger concerns, at prices usually fixed by the latter. Individual claims or groups of claims not yet bought by these large holders are either inaccessible, or are being held at too high a figure. In a few cases where the timber may be easily logged, the small holder exploits the area himself. Besides the privatetly owned timber there is a vast amount of stumpage in the Government forests, and on Indian reservations under Government control. It is from these great western forests that the bulk of the country's supply of wood will be obtained for many years to come. At the present rate of cutting they are practically inexhaustible, but the cut will increase many times in the next 25 years, as eastern and southern forests become depleted. However, with a decreas-

ing per capita consumption of lumber and an increasing percentage of utilization, the western forests could be quite easily perpetually maintained under good forestry management.

Investors in western timberland are largely from the Lake States and eastward. They witnessed the tremendous fortunes derived from the lumber business in the east and sought to duplicate these achievements in the undeveloped west. Great tracts of stumpage were purchased in the early days at low prices. As timber became scarcer prices rose and finally, in 1906, under keen competition, stumpage in certain regions reached a figure almost equalling its real value.

The true worth of standing timber is determined by the average mill run selling price of the product manufactured from it. The price is fixed by the most valuable product made from the species in question. It may be lumber, or staves or shingle bolts or any one of a hundred other commodities made of wood. From the average mill run selling prices are deducted the operating costs—logging, milling, and overhead charges—involved in transforming the standing tree into the finished product on board the car ready for shipment. A certain percentage is allowed on the costs of the operation and on the stumpage as profit. The remainder represents as nearly as can be determined the true stumpage value of the timber.

Outside the Forest Service, however, a totally different practice is followed in determining stumpage values. The basis of this system is the first cost of the standing timber. To this is added each year the carrying charges, consisting of taxes, protection costs, and administration expenses. A reasonable net annual return on the money invested is also expected. The nature of the investment makes it imperative that interest rates be higher than those obtaining for loans on property where the risk of destruction is not so great. The net annual return charged against stumpage is about 7 per cent. At this rate compounded semi-annually, stumpage doubles in price every 8 years.

Pacific coast forests are hardly maintaining themselves. The timber is mostly over-mature, and the loss from decay is not replaced by the added growth of the live trees. In certain regions, as the Wind River country in Washington, and on the Umpqua Forest in central Oregon, the trees are very largely dead or defective, and the annual loss by death and decay exceeds the growth many times over. The white pine forests of northern Idaho are just about holding their own. The growth in the younger merchantable stands which is normally quite large is kept down by the ravages of the white pine bark beetle (*Dendroctenus monticola*), until probably the destruction exceeds the growth. The older stands are deteriorating more rapidly from this and other causes. On the whole, owners of stumpage in the Pacific Northwest cannot expect any increase in value

of their lands due to increased growth. It may be said, however, that most investors in timber land do not figure on an increase in value due to increase in volume of mature or semi-mature stands, but are perfectly satisfied if the present growth does not materially decrease in quality or in amount until such time as it is cut.

The principal factor upon which investors in Western stumpage based their hopes of large profits, was the steadily increasing price of lumber and a corresponding rise of standing timber. The early purchaser of stumpage had ever reason to believe that lumber would continue to soar in price, since each year saw a diminishing reserve and an increased output. A study of past lumber prices shows a steady rise over a long period. There were short periods during depressions when lumber quotations remained stationary or even declined slightly, but normal conditions were quickly resumed with their passing. Favorably located stumpage, however, had never declined in price. Relatively speaking, it had never caught up with the lumber manufactured from it. It had constantly mounted to higher levels, and in so doing had made millions for fortunate investors.

Conditions in the lumber business have undergone a radical change in the past decade. Lumber prices have not risen as anticipated. In fact, for most species they have actually decreased since 1907. The decade prior to this date were boom times in the timber business in the West. Money was plentiful and timber was cheap and operators and investors bought up all the available stumpage in their buying spheres at low prices. As timber became scarcer, choice tracts increased in value, and by 1907 prices very nearly approaching the true value of the stumpage were paid in many regions in the West. With the panic of 1907, buying stopped as suddenly as it began. Sellers were holding for high prices which the buyers have been unwilling to pay.

The average mill run selling price of all lumber manufactured in the United States in 1906 was $16.54. In 1915 it was $14.04, which indicates a loss of $2.50 per thousand feet in ten years. Douglas fir dropped $3.61 per thousand feet; white pine, $ .88; spruce, $ .75; western cedar, $2.02; redwood, $3.10. The only increases were in western pine which advanced $ .31 and sugar pine which rose $1.29. The decreased selling prices indicate a decreased value of stumpage. Timber purchased in the days when stumpage was cheap and estimates low could stand the slump fairly well, but that bought at or near the end of the period when stumpage often brought its true value are really in a serious plight. Carrying charges and interest have mounted steadily upward each year, and for 10 years past the price of lumber has steadily declined, while stumpage has remained stationary.

Such a condition as outlined above, if maintained, must soon

A typical stand of coast timber on the Columbia National Forest, near Carson, Wash.

result in wholesale destruction of the forests to prevent loss on the part of the owners. A very good illustration is shown in the case of a certain tract of white pine in northern Idaho. Approximately 8,000 acres were purchased in the region in 1906 under severe competitive conditions, at prices very near the true value of the stumpage. During the next decade white pine lumber actually decreased in value $ .88 per 1,000 board feet. The carrying charges and return on the money invested demand that the timber be worth 125% more than the original purchase price. Four thousand acres of timber adjoining the 8,000 acres purchased in 1906 were acquired under competitive conditions in 1916. The prices paid were less per claim and less per 1,000 feet than for the contiguous tracts of timber purchased 10 years before. From these figures it is clearly seen that the calculated advance in stumpage did not materialize; in fact, during the period, based upon the selling prices of the finished product, the value of the standing timber actually decreased. During 1916, however, the selling prices of white pine lumber have advanced and the condition of stumpage has greatly improved. The 4,000 acres mentioned above were recently resold, for immediate cutting, at a very substantial profit.

White pine is a highly specialized wood. It is used for certain purposes for which there are no suitable substitutes. The ease with which the wood can be worked, together with its light color, even grain and freedom from shrinkage, warping and checking after seasoning, makes it highly desirable in the mill-working industries. Millwork plants consume over 50% of the total output. The demand for white pine is always strong. The supply of standing timber is strictly limited. There should be a steady rise in the price of lumber and of stumpage, as the exploitation of the forests depletes the supply.

Coast species, Douglas fir, western hemlock, western red cedar, white fir, redwood, spruce and others of less importance occur in heavy stands covering large areas. These woods, especially the firs and the hemlock, have no highly specialized uses, and actively compete with each other in the general trade. Statistics stated elsewhere show that Douglas fir, the species having the greatest volume of standing timber, the largest output, and the most diversified uses of all coast trees, decreased in value $3.61 per 1,000 feet b. m. in the ten-year period following 1906. Th value of stumpage has declined in exact ratio to the drop in the price of the manufactured product.

The selling prices of coast stumpage have not actually been lowered in recent years, neither have they advanced perceptibly. Substantial profits have been made on recent sales of standing fir timber, but the rise in prices was not due to increased values per thousand feet, but rather because more careful estimating has revealed heavier stands than earlier cruises indicated. Many of

the recent sales were made to operators who contemplate immediate exploitation, and hence were in a position to pay relatively higher prices than those buying as an investment.

Owners of coast timber have not realized their expectations in the matter of stumpage values. Early purchasers at low prices are realizing a fair rate of interest on their investments, but probably not greater than that obtained for money invested in other property involving much less risk of destruction. The profit, if any, will come through closer estimates of the timber showing heavier stands. Later purchasers paid higher stumpage prices on much closer estimates than were originally made. They cannot hope for a great increase in volume in the years to come, but must base their expectations of profits almost entirely upon the rise in stumpage values. As stated above, standing timber has not risen in value in ten years; in fact, it has actually declined. The prospects of increased stumpage values in the near future are not especially bright. Large exports to European countries and the extensive building of wooden ships, as now contemplated, may change the situation and bring about better stumpage conditions.

Except for species having highly specialized uses, the values of western stumpage will remain stationary or at least will rise only slowly for some time to come. The increased demand for wood after the great war will no doubt stiffen prices somewhat, but probably not permanently. There are many factors which tend to verify the above statement. Probably the most important one is the fact that many operators and investors own more stumpage than they can cut in a reasonable length of time. In order to protect their investments they must increase their outputs by building additional mills, or sell a portion of the stumpage to other operators. In either case more lumber is produced, and overproduction results. Overproduction means increased competition, which in turn means lower prices for the manufactured product. Since the value of standing timber depends directly upon the selling prices of lumber, stumpage also declines.

Another factor which will have a decided influence on western stumpage values for many years, is the fact that there still remains in the east great producing forests much nearer the large centers of consumption than is the coast timber. The Great Lake States forests are rapidly becoming exhausted and the southern mills have reached the peak in their production, hence competition with lumber from these regions will be less keen in the future and prices of western products will gradually rise.

It is doubtful, however, if the increase in prices due to the cutting out of the eastern forests will keep pace with the increased cost of production. Taxes on timber land have increased tremendously in every western state during the past decade. Protection costs are considerable and are mounting higher each year. Logging and milling costs have advanced materially in every

A well-ordered national forest timber sale area, after a cutting. Plumas National Forest.

An excellent stand of pure white pine in northern Idaho. The timber averages eighty thousand feet B. M. per acre.

region, due to increased wages, cost of equipment, materials and provisions.

The per capita consumption of wood is decreasing annually, and the output of the mills remains stationary. The number of wood substitutes is increasing yearly and the amount of wood displaced by them already equals about one-fourth of our total lumber cut. Wood preservation has made inroads into the lumber industry by doubling or trebling the life of timber. Much greater utilization in the forest, at the mill, and at the point of consumption, is practiced today than ever before. These and other factors tend to regulate the price of lumber and of stumpage; and though the country has actually less timber than it will consume during the next 50 years, under the present conditions of the lumber industry; it must be cut and disposed of as rapidly as possible to avoid loss to the present owners. Under conditions which exist today every owner of coast timber will be compelled to cut his stumpage within a comparatively short time, unless some relief is forthcoming. To cut the timber regardless of market conditions would be a national calamity. It is to be hoped that some way may be found to handle this extraordinary situation, so as to protect the owner, safeguard the public, and in this way save a great National resource from wanton exploitation and permanent destruction.

Planting Trees on Kansas Prairies

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Kansas always has been and always will be essentially a prairie state. But every year brings more convincing proof that her plains need not always remain treeless. Each planting season sees new effort put forth to beautify the Western Kansas homes and divest the plains of their traditional bleakness.

The state possesses a wide range of climatological conditions and physiographic features. In passing from east to west one notes a gradation from the wooded stream banks and timber belts of the eastern sections to the wide flat plains of the extreme west and southwest, where a tree becomes a novelty. The climatic conditions change from those of the average Mississippi Valley state to those of the plains regions. The rainfall drops from an average of 35 to 37 inches to an average of about 16 inches. The winds rise gradually until in the western section velocities of 20 miles per hour are very common and those of 35 to 40 miles are frequent. The lack of protective belts and the dry prairie soils increase their drying effects and enable them to carry the soils more and more, until in the western parts of the state soil blowing becomes a serious problem. The precipitation is likely to come more or less spasmodically, being heavy during the winter and spring of the year and little or none during the summer months. Hail is frequent and often does a great damage by defoliating and even barking old as well as young trees. Winterkilling becomes important, not because of the low temperatures, but because of the late fall and early spring warm spells. These sometimes occur as late as December and as early as February. Often sap will begin to rise. Nearly always such warm spells are followed by cold waves and freezing weather. Winterkilling is the usual result. Such conditions increase the vicissitudes and limit the scope of the tree planter's work. They make hardy species and intensive methods of moisture conservation imperative.

However, to those who really know the state it is not as wild and barren as popular opinion would have it, and there are evidences of earlier days which hold forth promise of a certain amount of success in tree planting for the future. It is probable that the Kansas plains were not always as destitute of trees as they are at present. For example, on the Fort Hays Experiment Station, which in the early days was the Fort Hays Military Reservation, a belt of heavy timber borders Big Creek as far as the reservation extended. Beyond these limits the timber breaks off suddenly

The type of Kansas home which the present generation is rapidly beautifying by tree and shrub planting.

A view in the timber belt bordering Big Creek, on the Fort Hays Experiment Station, Hays, Kan., formerly the Fort Hays Military Reservation. The above shows Custer's Island, where George A. Custer and party were surrounded by Indians, later marooned by high water and finally forced to swim their horses out to escape.

and is then noticeable only in irregular blocks along the stream. Evidence of single specimens or small groups of very old mature timber along other creek bottoms and along draws throughout the Western section seem to point further to a day when these lower areas and stream banks all may have been more extensively wooded. Many instances are found, too, where tree growth breaks off in a sharp line just beyond some stream or other natural barrier. It is not at all improbable that these are the results of destruction by fire. The Indian of the early days fired the prairies to destroy pasture and game against the approach of his unfriendly neighbors, and in so doing he was not scrupulous about encroaching upon any timber land which might have existed. The great prairie fires which have become more or less history, regardless of their origin, undoubtedly decreased any existing timber areas. Then, too, the early settler demanded fuel and structural timber. Just how far-reaching such destruction was is difficult to say in view of the remaining remnants of the old sod house and of the reports of the great distances to which lumber was carried overland. However, it is reasonably safe to suppose that inroads were made on any native timber then standing.

Nevertheless, trees were then, as now, "conspicuous by their absence" in Western Kansas, and the second generation of settlers especially, who were not compelled to spend every spare minute to win a bare existence from the soil began to demand trees of some kind. The earliest efforts at tree culture were made in the form of the old "tree claim." Spotted all through the western sections of Kansas may be found remnants of these plantings in varying stages of preservation. They do not exhibit magnificent trees, but they give promise of better results with more intensive methods. In nearly every case the plantings have become scraggly and deteriorated, mostly because of neglect and very often because of poor varieties. Land was the object of the plantings, not trees. As a result they were set and left to their own salvation in the battle against the hardships of the soil and the prairie sod.

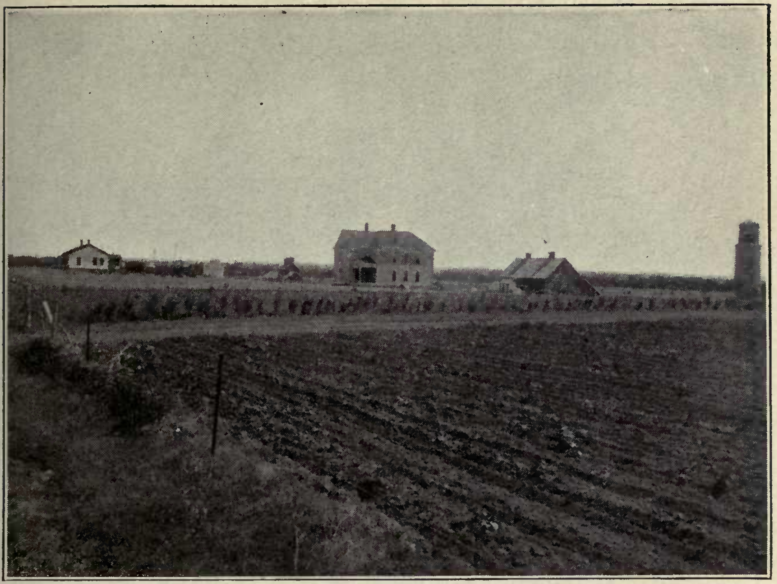
The present generation, however, are no longer land seekers; they have become land-owners and home-builders. Now comes a new demand for trees to make Kansas homes more livable. Through this second demand or awakening has come more systematic effort, and gradually the people are beginning to realize that tree planting is not an impossibility, that it is a necessity, that it will pay in some form or other sooner or later. It was to further these efforts that a State Forestry Department was established with a State Forester at its head. Two state nurseries are now maintained, one in the Eastern and one in the Western section of the state. The stock is distributed to the people of Kansas at the cost of production. Kansas has again been brought

to face the tree planting problem; but they are being attacked in a new light.

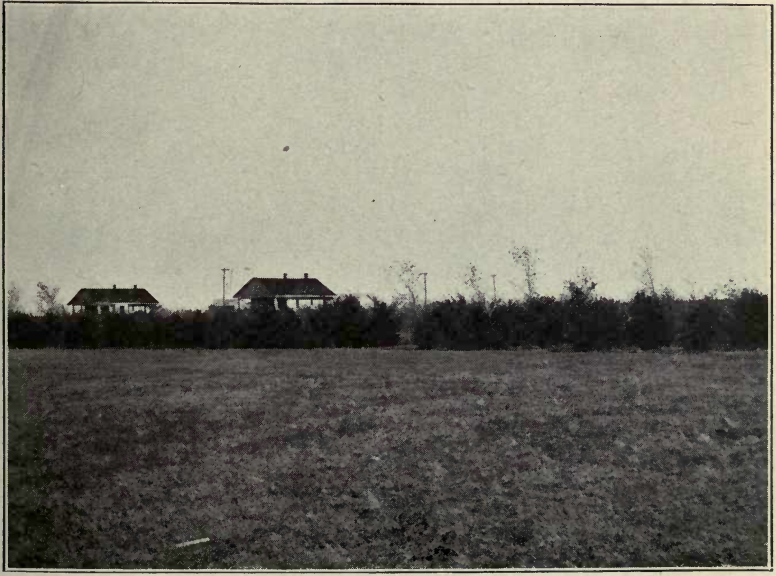
It is perhaps safe to say that the maintaining of a nursery in Western Kansas is one of the greatest stimuli to tree planting. A commercial nursery in this section at the present stage would undoubtedly "go broke." The state is about the only institution which can afford to handle such a proposition for the sole purpose of "furthering the cause." The results that are being obtained justify the maintenance of the institution. Through the Western Nursery, located at the Fort Hays Experiment Station, Hays, Kansas, the source of supply is placed much nearer to the purchaser and furnishes planting stock at a season which is comparable to the planting season in this section of the state. While it may seem a small item to say that many people are induced to plant trees through visiting the Forest Nursery and through simply feeling that the stock is near at hand, in reality this influence is surprisingly large. The majority of the trees shipped from the Hays Nursery go to the Western part of the state, and the "yard business" is nearly as large as the mail order business. A large number of the Western Kansas farmers have only moderate incomes, and they look at the increased freight and express charges for long distances a long time.

Then, it is important that the stock be ready to plant when the time comes to plant it. The planting season is apt to be short, early or late. Where the stock is raised under the conditions of the region it keeps pace with the season so that it lies dormant or begins to grow according to local conditions. This is apt to cause less delay if the season is early or furnish stock which is not too far advanced if the season is late. This factor is not important where the seasons change steadily, but where there are such fluctuations as in Western Kansas it has an important influence. Also, if hardy varieties are to be found and raised they must be tested under conditions prevailing.

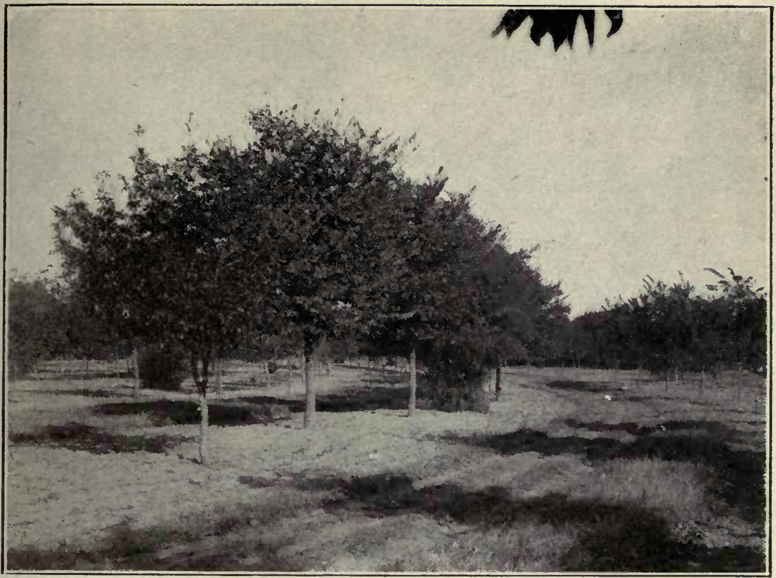
In spite of all the need for trees, the Forester still has problems to overcome in furthering the tree planting movement. He has to bring the people to adapt their ideas of tree growth to existing conditions. A large part of the population has come from sections of the world where trees have grown in abundance and with little or no care. Kansas was treeless when they arrived; it surely was supposed to remain so, in their judgment. Popular belief has said, "Trees cannot be raised in Kansas," and this has settled all debates for many. The early efforts in the form of the old "tree claim" were a failure. To others this is conclusive proof. Regardless of the results of plantings in older towns and the specimens that exist where care has been given, it is hard to convince the "old timer" that he can afford to plant a tree. Such convictions have their foundation, it is true. A season such as 1915 with a total of 34.14 inches rainfall



Shelter belt planted in 1905 and 1906.



Same shelter belt from opposite side seven years later.



A view of the park maintained by the Fort Hays Experiment Station at Hays, Kan. The above was taken in 1912, seven years after planting. Cultivation maintained throughout.

A hackberry plantation in western Kansas, three years old. Rows are four feet apart. A hardy variety for this section.

well distributed throughout the year adds enthusiasm to the tree planting movement; but one like the past season of 1916, with only 16.01 inches rainfall and only 5.3 inches of this amount after June first, is exactly the opposite and requires a great amount of optimism and persistence. Trees 12 and 15 years old which have been thrifty, well established and well cared for have died in the one season. Then further, the idea that the trees raised are not worth raising puts out of the running many who have become accustomed to the tall stately tree of the timber regions from which they came. It is hard to convince them that the low topped, bushy growth is best adapted and is really a tree; that it must serve at least as the forerunner of the more stately type. Such are the prejudices which must be overcome.

Winds are perhaps as limiting a factor to tree growth as any other. There is no question as to their effect upon tree forms and plant life. A tree grown in the open is almost certain to become one sided, and even when grown where partially protected shows the one sided effect distinctly. Besides, the winds during the growing season, of a dry year especially, are hot and drying and evaporation is extreme. For these reasons the low headed bushy tree is the best type adapted to the region. The success of the tree planting movement, therefore, depends largely upon the development of wind and drought resistant varieties.

The greatest education needed is, as in any forestry movement, that of the care of the tree. If it is important to cultivate, water and care for tree plantings in more favorable climates, it is doubly important in the prairie state. Vegetation which does exists, exists because of its very ruggedness and ability to withstand hard usage. It will take a tree of the same type to battle against it, and there are few species which will do so without help. With help much can be accomplished. Species which have been found to withstand conditions best are: White elm, Norway Poplar, Honey Locust, Kentucky Coffee tree, Tamarix (shrub and hedgeplant), Osage orange, Russian Mulberry, Russian Olive, Redbud, Cottonwood, Hackberry, Chinese Arborvitae, Red Cedar (*Juniperus Virginiania*) Austrian pine and Yellow pine.

The best trees are those which have been longest cared for. A public park maintained by the Fort Hays Experiment Station, which has been planted between 10 and 12 years, has been kept under thorough cultivation. The trees have made a remarkable growth and now stand as excellent examples of what can be accomplished with care. Another plantation of Catalpa (*Catalpa speciosa*), now 11 years old, has produced between 250 and 300 fence posts on 1½ acres, the posts averaging about 4 inches top diameter. While such may be only scattering exam-

ples, they show what can be accomplished with a certain amount of effort.

The tree planting movement will gain in proportions as the people learn the possibilities and realize the effort needed. The percentage of loss is greater than in more favorable climates, hence, the effort must be proportionately increased. But the value of the surviving per cent is so much greater in comparison that it should be looked upon as well worth the added effort. As the people realize this more and more they are increasing their interest and persistence.

The State Nursery at Hays is maintained in connection with the Fort Hays Experiment Station. From a Nursery of approximately one acre 5 years ago and containing but a few trees it has grown to one of 25 acres and contains some 250,000 trees and plants of various ages and sizes. The demand for trees that the Nursury produces has grown in the same time from a few trees planted at the Station for demonstration purposes to one of approximately 75,000 trees, which represents the approximate number shipped to all parts of the State each year. Of the trees sent out the number reported living after the first season's growth has increased from 76% to 91%. Out of some 480 orders during the spring of 1916 only 12 went to points outside of the State.

Charts for each of the past five years showing points to which trees have been shipped from the Hays Nursery, show also that the Western sections of the State are receiving a larger proportion of the orders from the Nursery each year. With one exception, when there was a general decrease in the number of orders all over the state, the west has increased steadily while the east has fallen off. During the past year there was an increase in the two western sections of 37% and 146% respectively.

Thus, the desolate plains of Kansas are rapidly becoming farm homes, and the homes are being beautified. It will undoubtedly be a gradual process which gives the state any extensive timber belts, but the persistent efforts at shelter belt, shade tree, and shrubbery planting are bound to increase, and it is not unreasonable to dream of a day when the plains will be spotted with trees, marking the prosperous homesteads of the wheat farmers of the Sunflower State.

Part of the Forest Nursery maintained by the state of Kansas at Hays. The stock is distributed at the cost of production to the people of Kansas.

Scaling and Check Scaling in the U. S. Indian Service

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Practically all timber cut from Indian land is sold by actual scale, so the scaling is one of the most important parts of every timber sale. Large sales are often made, requiring several years to cut and necessitating several camps in operation all the time. Each camp requires a scaler, so several scalers are usually employed all the time. The men who fill these positions are chosen from the best scalers in the community and have usually had several years' experience. This would seem sufficient precaution to take to obtain a good fair scale to all parties concerned, but it has been found true in all lines of work where a man does the same thing day after day that he becomes more or less mechanical in its performance, and this is true in scaling logs the same as in other work. To obviate this tendency and to keep the scalers alert at all times, the U. S. Indian Service has inaugurated a system of scaling and check scaling which brings out the best efforts of the men at all times and incidentally gives as nearly a correct scale of the logs as it is possible to obtain.

Timber sold from Indian lands falls into one of two classes—Allotted timber or Tribal timber. If the timber is cut from allotted lands the allottee receives all the money from the sale of timber on his own allottment, so it is necessary to keep a separate scale for each Indian. If tribal timber is being cut, each land sub-division is kept separate when scaled, even though the money goes into a fund for the tribe, and is either used for some help to the tribe as a whole or divided pro rata among them. Each sub-division is kept separate to make the handling of the funds easier, for all the money is usually held in trust by the government for the individual Indian, or the Tribe, and can be spent only under supervision. This will show the reason for the scaling units referred to later.

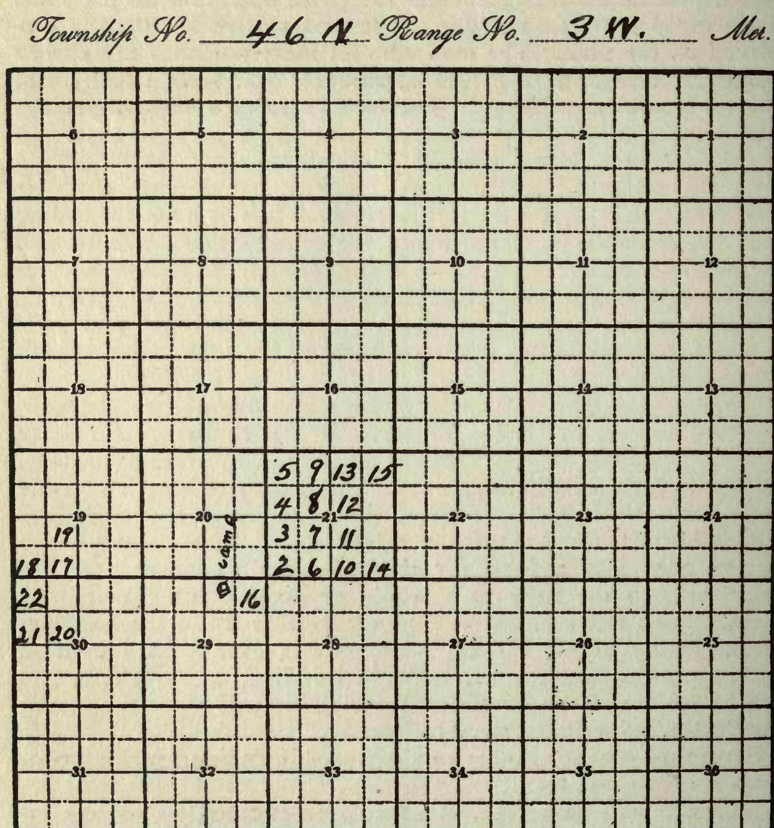
Paragraph 9 of the timber contract used in Indian Service timber sales reads as follows:

"Timber will be scaled, measured, or counted by officers selected by the officer in charge. The cost of scaling and of supervision by the United States officers shall be paid from the proceeds of the sale of the timber. Timber will be scaled by the Scribner rule, Decimal C, and if required by officer in charge, shall be piled or skidded for convenient scaling. The maximum scaling length of all logs will be .. feet. Logs over ..

feet in length will be scaled as two or more logs in length not less than .. feet when practicable, and with the proper allowance for the increase in diameter at the points of division. Upon all logs 3 inches additional will be allowed for trimming. Logs overrunning this allowance will be scaled as though 2 feet longer. Diameters will be measured inside the bark at the small end of the log and recorded at the nearest inch above or

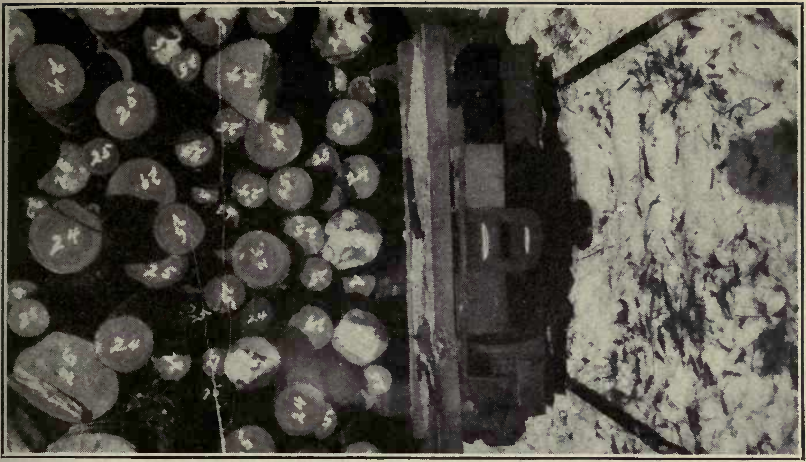
Fig. 1.

[4—590.]



below the actual diameter. Proper deductions will be made for defects in logs."

The blanks in the above form are filled out differently in different localities, depending on the nature of the timber. At the La Pointe Agency the maximum scaling length under the latest



Lot number end, showing this load containing logs from two descriptions, No. 29 and No. 25.

Scale number end of another load.
Series 2235 to 2262—white pine.
Series 1820 to 1831—hemlock.
Series 962 to 966—balsam.

contract is 18 feet. Logs over 18 feet in length are scaled as 2 or more logs in length not less than 12 feet when practicable.

The timber cut from Indian lands is always scaled before it is removed from the cutting area, usually on the land from which it is cut. In some cases, however, it is not practicable to scale on land, because of loading conditions in sleigh or dray haul camps, in which case the logs are scaled on the landing before they are put into the river or stream down which they are taken to the mill.

When a camp foreman receives his cutting list for the season he confers with the scaler assigned to his camp, and they designate each allotment, or sub-division of 40 acres, by a number as shown in the accompanying diagram (Fig. I.). The reason the descriptions to be logged here are scattered is because the area has been logged previously and all other timber removed from the locality.

As the area is cut over and the logs are skidded the number of the description from which each log is taken is placed on one end of the log, usually on the left hand end when facing the front end of the skidway. These numbers are put on the logs with black lumber crayon by the men who "tail down" at each skidway. The teamsters and foreman keep the logs separated as much as possible so only one description is logged at a time, but when logs are skidded to one skidway from more than one description the skidway man is always told what description the log comes from so he can number it correctly.

The logs from each description are recorded separately in regular scale books, the lot number always showing the description from which the log was cut. Sometimes a scaler is compelled to carry 8 or 10 scale books with him every day, especially in railroad logging, when one branch crosses several descriptions and loads are taken from each.

When the logs are scaled, each log must be numbered again with the scaling number, on the opposite end from the lot number, and the number on the end of the log must correspond to the number in the scale book opposite which the scale is recorded. This brings the scale number on the right hand end of the log when facing the front end of the skidway. Of course, this exact method may not be followed but it is easier for the scaler to put the scale number on the right hand end, and it is usually done that way.

Several species of timber are usually found on each description and in order to make the work of recording and reporting the scale easier, each species is given a series of numbers, or the leading species is given one series, and all others are grouped under another series. In the latter case the mixed logs are grouped under one series but each species is recorded on a separate page, or in a separate column of one page. For

example, if white pine predominates on one description, the white pine logs will be numbered beginning with 1, consecutively, until all are numbered or until the number 10,000 is reached, when the series again begins with 1, but with a line beneath as 1, 50, 697, etc., thus doing away with writing large numbers. All other logs from this description are classed under another series, exactly as above in numbering. The species, however, may be arranged as follows: Norway Pine, 1 to 100; Hemlock, 101 to 200; Spruce, 201 to 220; Balsam, 221 to 240; Birch, 241 to 260; Maple, 261 to 280; Oak, 281 to 300, etc., depending of course on the amount of each species on the description. The scale books used contain 75 sheets or 7,500 logs in each book. When one book is filled on one description another one is started, taking the numbers beginning with the next number above the last one in the old book, continuing until all the logs are scaled.

The actual scaling of the logs is done with the Scribner Decimal C rule. Deductions are made for defects and this, of course, is the place where judgment is necessary. Various defects, such as sap rot, stump rot, punk, shake, fire scars and damage, ant holes, dry rot, etc., all require different methods of figuring deductions, and the scaler must be sure of the scale of every log before he records it, for the inspector may decide to find out how much he gave for it. Lengths should be measured often for the sawyers sometimes make mistakes of a few inches in length, which often increases the scaling length of the log.

The scaler must be very careful to always record the scale of a log opposite its number for his book is his only record. It would be easy to get the scale mixed if the scalers were not always open to inspection and required to keep their books correct.

When the logs are being hauled by rail, and often in sleigh haul camps, they are moved or loaded so fast that it is impossible for one man to number and scale them, and keep ahead of the crew. In such cases a marker is provided for each scaler who numbers the logs as they are scaled. This gives the scaler time to inspect each log and be sure of his scale. A good scaler, with a marker, can scale from 125,000 to 200,000 feet of timber per day if necessary, varying, of course, with the size of logs and the average amount of defects.

Each scaler reports at the end of each week all timber scaled by him during the week, a separate report being required for each description from which logs were taken. Four copies of each report are required, one to go to the purchasing company, one copy to the Indian Agent's office for the use of the clerks in figuring the value of the timber, one copy to the Indian allottee, if land is allotted, or to the inspector if the land is tribal, and one copy for his own reference, in making the next report from

that description, or for reference in case any trouble ever comes up regarding the report.

These reports are made on regular forms. The first column represents the number of logs of each species scaled on the particular description during the week; the second column, the scale for that number of logs. The two columns headed "Previous scale" show the number of logs and the scale for all timber previously taken, and the last or "Total scale" gives the total of the first two, or the total number of logs and total scale up to the date of the report. It is easy to figure from these reports the value of the timber removed at any given date, and if the original estimate is known, approximately the amount of timber is left on the area.

SCALER'S REPORT

For Week ending May 13" 1916 of Logs Cut and Banked from Tribal Allotment on the Lot 6 S.E.¼ N.W.¼ of Section 12, Town 46, Range 3 West, on the Bad River Reservation, Wisconsin, for J. S. STEARNS LUMBER CO., by Ed McDonald

KIND OF TIMBER	SCALED DURING WEEK		PREVIOUS SCALE		TOTAL SCALE	
Mer. Green White Pine	1800	133250	2200	183660	4000	316910
Green Norway	18	1040			18	1040
Green Hemlock	80	3030	46	1190	126	4220
Basswood	51	2210	155	5600	206	7810
Elm	41	1600	17	790	58	2390
Ash	1	30	16	790	17	820
Maple						
Birch	4	140	2	90	6	230
Oak						
Spruce	9	300	1	10	10	310
Tamarack	40	1520			40	1520
Balsam	47	1010	63	1470	110	2480
Poplar						
Cedar	9	210			9	210
TOTALS	2100	144340	2500	193600	4600	337940

W. J. Bohan ..... SCALER

Each scaler's work is checked up every week or ten days and the results reported to the Chief of the Indian Forest Service at Washington, D. C. Regular inspection forms are used, and are kept by the inspector, and are open to inspection at any time by the Chief or anyone from the Washington Office.

In checking up a scaler's work the inspector selects the logs he will scale and puts the number of each log in the column headed "Log No." and opposite this number in the column headed "Insp." his scale of that log. Usually 100 or more logs are

taken for a check and these may be taken wherever the inspector chooses, or of any species or several species. When the desired number of logs have been recorded and scaled as described above, the inspector takes the scaler's books and looks up the logs and records the scale found in the book for each log in the column marked "Scaler." Each column is then added up and the total scale given by the scaler and inspector found. The difference of these two will show the difference of scale for the total number of logs, or the per cent of difference can be easily found. This variation may be as much as 1% in good timber, or even 2 or 2 1-2% in large, shaky hemlock, and be considered close, but if greater than that something is wrong.

The check scale often shows the variation on some individual logs to be very large in comparison with the total variation. This is due to differences in judgment of the seriousness of defects. It is impossible for two men, no matter how good scalers they may be, to agree on the scale of large, defective or partly rotten logs, but if several are scaled and one man's scale varies back and forth with the other, the average will be very good and all that can be expected. The smaller differences are due to the reading of the rule. This is possible because of the system used of taking the nearest inch above or below the actual diameter as the scaling diameter. If the actual diameter is near the half inch, or the log is not exactly round, it is very easy for one to make a difference of one inch on the diameter, either above or below the other, thus making a difference of 10, 20 or even 50 feet on one log. These differences, however, always vary back and forth so they about balance if a large number of logs are taken as a check.

The method of checking up with each scaler every week or ten days 100 logs at a time is better than taking a larger number of logs at longer intervals. The usual 100 logs will be enough to equalize the difference due to reading the rule and if several defective logs are taken the scaler's judgmnt of such logs can be obtained as well as if more were taken. This will always keep the scaler "on the job," too, and doing his best, for he never knows when the inspector will be around or where he will select his logs for the check scale. A scaler can never slight his work or guess at the scale of the logs, for the inspector may find them. If a scaler averages too large a scale, even though it favors the Government, or the Indian, he is just as sure of being discharged as if his scale was too low.

When the area has all been logged over and the work is done for the season, several scalers are taken to each camp in turn, usually all of the scalers go together from camp to camp and make the "pick up" as it is called. This means that the crew goes over very carefully all of the area logged over during the

season and if there are any logs found that should have been taken they are scaled, stamped with the regulation U. S. hatchet and reported the same as the other logs. If the purchasing company wants to go over the area and remove these logs they have a perfect right to do so, otherwise they are left in the woods. This feature encourages closer utilization of the timber and insures cleaner work on the part of the company than could be gotten in any other way.

This does not complete the inspection, however, for the inspector may find an inspector from Washington in town any day, and have him go to the camps with him and check up both his work and that of the regular scaler. Usually the inspector and the Chief from Washington both scale the same logs, then check up with the scaler. If the scaler's scale does not agree with the inspector's scale, or with the Chief's scale, or the inspector's scale does not agree with the Chief's scale, something is wrong and someone will probably be fired, and you can be reasonably certain it will not be the Chief.

The Flora of Lake Vermillion Minnesota.

L. H. PAMMEL, Ph. D.
Professor of Botany, Iowa State College.

Lake Vermillion is situated in the Northern portion of St. Louis county, north and a little east of Duluth and may be reached via the Duluth and Iron Range Railway. The lake is only 35 miles long, but it has 800 miles of shore line. In many places the shore line is rocky, in others, however, there are sandy beaches. The lake is noted for its many islands. Those who profess to know, state that there are 355. Some islands are only 100 feet square, while one of the large islands contains several thousand acres, including several small lakes. The depth of the lake varies from a few feet to 150 feet. At one time there was considerable timber in the region, mostly white pine *(Pinus strobus)*, red pine *(Pinus resinosa)* and some Jack pine *(Pinus divaricata)*. Paper birch *(Betula papyrifera)*, balsam fir *(Abies balsamea)*, Arbor vitae *(Thuja occidentalis)*, tamarack *(Larix laricina)*, white spruce *(Picea canadensis)*, black spruce *(P. mariana)*, black ash *(Fraxinus nigra)*, and Balm of Gilead *(Populus balsamifera)* occur in swamps and along the streams. There is also *Populus grandidentata* on a few islands. Other species of trees occur but they are scarcely merchantable. These trees are as follows: Bass wood *(Tilia americana)*, hard maple *(Acer saccharum)*, red ash *(Fraxinus Pennsylvanica)*, and green ash *(F. Pennsylvanica* var *lanceolata)*. The pin cherry *(Prunus pennsylvanica)* is common everywhere, especially in burnt-over areas. The choke cherries *(P. virginiana)* is also common, but never attains the dimensions of a tree. The quaking aspen *(Populus tremuloides)* is one of the common trees, never, however, of large size. Mountain ash *(Pyrus Americana)* is always a shrub or a very small tree. The oak *(Quercus ellipsodialis)* is a rare tree occurring on Pine Island. The blue beach or iron wood *(Carpinus caroliniana)* was only found once at the lower end of the lake, near the Vermillion dam. It was shrublike and only leaves were observed. This locality makes apparently the most northern limit in Minnesota for the species. The speckled Alder *(Alnus incana)* is common in the swamps and on the shores of the lake. American elm (*Ulmus americana*) is confined to the streams and beaches of the lake.

The shrubs and herbaceous plants are important because of their relation to the growth of forest trees. The importance of the associated plants has been considered by many botanists. Woodsmen have often observed that when the associated plants are removed the forest trees are short lived. In conversation with Gus. Fabin, who owns a cottage at the head of Fabin's Bay, when the dying of balsam fir in front of his cottage was mentioned he said, "I have often noticed that when you remove the associated trees the balsam fir is a short lived tree."

The more important shrubs of the region are the following: *(Salix amygdaloides)*, on the beaches, not common. Cordate willow *(Salix cordata)*, Sandbar willow *(S. longifolia)*, bog willow *(S. pedicellaris)*, gaucous willow *(S. discolor)*, beaked willow *(S. rostrata)*, Sweet gale (*Myrica gale*), beaked hazel (*Coryus rostrata*), swamp birch (*Betula pumila)*, June berry or service berry *(Amelanchier spicata)*, Red raspberry (*Rubus idaeus var aculeatissimus*), dwarf raspberry (*R. triflorus*),

Birch and balsam in the Lake Vermillion region.

Beach in front of Fabin's cottage.

dew berry *(R. canadensis)*, rose *(Rosa blanda)*, sumach *(Rhus glabra)*, poison ivy *(R. toxicodendron)*, bitter sweet *(Celastrus scandens)*, Mountain maple *(Acer spicatum)*, and Buckthorn *(Rhamnus alnifolia)* along the river courses. Virginia Creeper *(Psedera quinquefolia)*, Dwarf cornel *(Cornus canadensis)*, round leaved cornel *(C. circinata)*, and red osier *(Cornus stolonifera)*. The following occur in the Muskeg or on the borders of the same; Labrador Tea (*Ledum groenlandicum*), pale laurel *(Kalmia polifolia)*, Bog Rosemary *(Andromeda polifolia)*, Leather leaf *(Chamaedaphne calyculata)*, and Cranberry *(Vaccinium macrocarpum)*. The following in pine forests; Wintergreen *(Gaultheria procumbeus*), Bearberry (*Arctostaphylos uva-ursi*), Creeping snowberry *(Chiogenes hispidula)*, usually in swamps, Blueberry *(Vaccinium pennsylvanicum)*, Bush honeysuckle *(Diervilla lonicera)*, American fly honeysuckle *(Lonicera canadensis)*, Swamp fly honeysuckle *(L. oblongifolia)*, and Twin-flower *(Linnaea borealis)*.

The table on the next page gives the percentage population of trees in the vicinity of Fabin's cottage and Birch Point, as well as the plant population in the vicinity of Tower and Sudan.

The associated shrubs and trees in the above areas are given in percentages. The mountain maple and dogwood are not always mentioned. A study of the table will show the different types of associated plants and the abundance of the same. The Muskeg swamp contains *Picea mariana, Larix laricina, Betula pumila,* and *Alnus incana,* the latter on the border. The following shrubby plants occur; *Camaedaphne, Andromeda polifolia, Vaccinium macrocarpon.* Such plants as *Sarracenia purpurea, Carex filiforme* and *Spiranthes.* Sphagnum occurs scattered over the Muskeg.

The more important plants growing with the balsam fir, white pine, paper birch and quaking aspen are the following: Bush honeysuckle *(Diervilla lonicera)* with pale yellow flowers, the dwarf cornel *(Cornus canadensis)* with its bright red fruit, and the mountain maple *(Acer spicatum)* characteristic of all of the upland woods. The Clintonia *(C. borealis)* with its blue fruit early in August was conspicuous. In all of the recent clearings great quantitiies of *Aster corymbosus* were present. The trailing twin flower *(Linnaea borealis), Smilacina bifolia, Rubus idaeus* var *aculeatissimus, Lycopodium lucidulum* and *Pyrola secunda* were common everywhere in the woods. The dogwood *(Cornus circinata)* on the shores of the lake and the red dogwood *(C. stolonifera*) in tamarack and spruce swamps. In a stage beyond the Muskeg one finds pools of water standing. These swamps contain the black ash, alder, balsam fir, *Alisma plantago* var *americana, Cicuta maculata, Glyceria canadensis, Calamagrostis canadensis,* wild calla *(Calla palustris)*, and the swamp fly honeysuckle *(Lonicera oblongifolia)*. In the upland woods the following species are common: the Currant *(Ribes triste), Black currant (R. prostratum)*, Bishop's cap *(Mitella nuda)*, Marsh marigold *(Caltha palustris)*, Beech fern *(Phegopteris dryopteris)*, Sensitive fern *(Onoclea sensibilis)*, Willow *(Salix rostrata)*, Alder *(Alnus incana), Hydrocotyle americana, Geranium robertianum, Campanula aparinoides, Lycopus americanus, Mentha canadensis, Pteris aquilina, Arctostaphylos uva-ursi, Lathyrus ochroleucus*, Rattlesnake plantain *(Epipactis pubescens)*, Bottle grass *(Asprella hystrix*), *Uvularia grandiflora, Smilacina racemosa,* Poison ivy *(Rhus toxicodendron)*, Bitter Sweet *(Celastrus scandens)* and Virginia creeper *(Psedra quinquefolia)*. On the beaches the following plants are common: Sumach *(Rhus glabra)*, Hair grass *(Agrostis scabra)*, Strawberry *(Fragaria virginiana)*, Rose *(Rosa blanda)*, Columbine *(Aquilegia canadensis)*, Red ash *(Fraxinus pennsylvanica)*, occasionally Dogwood *(Cornus stolonifera)*, and *(Aspidium spinulosum)* in woods back from beach.

	Upland Near Fabin's Cottage.	Swamp Near Fabin's Cottage.	North Slope Birch Point.	East End Birch Point.	Near End Birch Point.	Near Birch Point	At the Very End of the Point.	Schively Lower End of Lake.	Tower and Sudan Marsh and Upland.	Muskeg Swamp Border.	Muskeg Swamp Interior.	Swamp at East End of Fabin's. Bay.	Pine Island.	Pine Island Shore.	Isle of Pines.	Strawberry Island.	East End of Fabin's Bay.
Picea mariana		5.97			16.65			.99	3.64	20.00	33.76	4.29					
Picea canadensis	5.59			15.12				1.98	3.64				1.66	1.90	10.14	.45	
Abies balsamea	20.86	16.07	14.54		16.65			8.91	1.63			2.70	3.94	14.04	6.21	8.55	
Thuja occidentalis	4.58	24.46					1.69		4.36			10.58			8.28	16.20	
Pinus resinosa	3.56		2.72	22.03		1.00			12.18				14.84	31.93	13.93		
Pinus strobus	2.03		1.81	2.01		1.50		9.97	10.39				4.17	3.70	10.55	.90	
Pinus divaracata			1.81	3.45											4.23		
Larix laricina			3.43		25.33				.728	16.00	36.32	3.53					*
Taxus canadensis												4.08	3.48	5.51	5.17	16.20	
Populus tremuloides	24.45	5.09	6.36	8.20		5.52	5.08	24.73	4.36								
Populus granidentata													.696				
Populus balsamifera									5.55			1.90					3.54
Betula papyrifera	15.77	1.39	36.63	19.80		12.04	4.33	15.84	8.74			1.08	15.18	13.22	15.79	25.20	
Betula pumila										10.00	19.92						
Acer saccharum				4.32		33.13											
Acer rubrum	3.05		5.45	4.32				11.01	10.55			5.06	1.39	6.96	3.31		
Acer spicatum						7.53							11.60	4.20	2.89	1.45	
Tilia americana			12.72			15.50	1.69							8.56		.90	
Ulmus americana							1.69	1.05	2.91			8.79		.428			2.12
Rhamnus alnifolia									2.00								
Cornus circinata				6.48		7.53	8.47		2.72				5.80		7.14		
Cornus stolonifera					11.10		8.47		2.72			3.00	5.80		3.72		
Amelanchier spicata			2.72	4.32		6.02	3.38						1.39	2.04	2.48	1.25	
Prunus pennsylvanica	11.70		2.72	3.47		2.00	7.62	3.96	1.09				1.524	1.50		13.95	
Prunus virginiana			9.09			8.23	35.57						1.39	2.25		2.25	
Pyrus americana							.847	2.72					.232	.952		5.00	
Fraxinus nigra	2.03	26.55						4.95	6.18			20.66		.958			9.54
Fraxinus pennsylvanica var lanceolata	2.03	3.49					2.54							1.90		.45	
Fraxinus pennsylvanica							5.92					15.97					1.06
Alnus incana	3.051	11.10			*20.30			15.84	10.28	34.00		7.55	20.57			5.00	72.60*
Corylus rostrata				4.32			8.47										
Myrica Gale					60.65							3.00					11.14*
Salix rostrata		5.88		2.16	*3.32				2.72			7.61					
Salix discolor	1.29						4.233	5.05	3.64				6.338		6.16	2.25	
Salix amygdaloides																	
Salix pedicellaris																	
Ledum groenlandicum										10.00	10.00						

NOTE—*Peat Bog.

Pine Island, one of the large islands still has considerable standing white and Norway pine. Interspread with these species are the following trees: red maple, basswood, paper birch, balsam fir and arbor vitae. The undergrowth consists mainly of *Cornus circinata, Corylus rostrata, Acer spicatum*, and *Diervilla lonicera*. Near to the shore lines, *Cornus stolonifera* and *Myrica gale*. The herbaceous plants are much the same as on the mainland. Of the conspicuous plants mention may be made of *Clintonia borealis, Arctostaphylos uva-ursi, Linnaea borealis, Pyrola secunda, Equisetum sylvaticum, Vaccinium pennsylvanicum, Rhus toxicodendron.*

Several small lakes occur on the island. In Bass Lake *Nuphar advena* was observed in abundance. On the shores there was an abundance of *Iris versicolor, Sium cicutaefolium, Calla palustris* and *Calamagrostis canadensis.* A small island lying a short distance from Birch Point, the Isle of Pines, contains some virgin white and Norway pines. The rock is near the surface. Of the plants observed mention may be made of the following: an abundance of *Polytrichum juniferinica, Diervilla lonicera, Aspidium spinulosum, Pteris aquilina*, and *Poa nica, Diervilla lonicera, Aspidium spinulosum, Pters aquilina*, and *Poa serotina.* Strawberry Island near Fabin's Bay and Birch Point has a much smaller area than the other islands. All of the virgin pine has been removed, young white spuce, white pine, arbor vitae are growing up thickly. The rock lies close to the surface. *Poa serotina* covered all of the vacant places. In dry places near the shore *Rhus glabra, Gnaphalium*, and *Cladonia rangerferina*. The *Lycopodium dendrodeum. Aster corymbosus, Rosa blanda, Cornus circinata, Diervilla lonicera, Hieracium canadense, Fragaria virginiana, Rubus idaeus* var *aculeatissimus, Epilobium spicatum, Chimaphila umbellata, Epipactis pubescens, Solidago ulmifolia, Ribes triste, Polypodium vulgare, Aspidium spinulosum, Pyrola secunda, Prunus virginiana*, and *Prunus pennsylvanica.* All of these islands soon become covered with vegetation after a fire.

The lower end of the lake at the dam contains an interesting lot of plants; *Clintonia borealis, Eupatorium purpureum, Polygonatum biflorum, Smilacina racemosa, Asplenium Filix-femina, Aspidium noveboracense, Impatens fulva, Aspidium spinulosum, Castalia odorata, Nuphar advena, Scirpus lacustris, Scirpus atrovirens, Lemna trisculca, Aster umbellatus, Solidago serotina*, and *Viburnum opulifolium.*

Some of the introduced plants found in the vicinitiy of Birch Point, Schively and Tower are as follows: *Cirsium arvense, Iva xanthiifolia, Helianthus annuus*, Russian thistle *(Salsola Kali* var *tenuifolia), Nepeta Cataria, Tanacetum vulgare, Artemisia biennis, Xanthium canadense, Erigeron canadensis, Phleum pratense, Trifolium repens, T. pratense, T. hybridum*, and *Rumex crispus.*

No attempt is made to give any of the literature bearing on the plants of the region. It will only be necessary to refer to two papers, the most important of which is by J. C. Arthur, which includes the botanical work of Holway, Arthur, Bailey and Upham who did work in the region in the eighties. Their camp was located in 48° north latitude near Lake Vermillion. The trees and shrubs of the region are given by F. C. Clements, C. Otto, Rosendahl and F. K. Butters in their Minnesota Trees and Shrubs."

L. H. Bailey in the above contribution lists the white ash *(Fraxinus*

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*Rep. Botanical work of Minn. for 1886. Bull Geol. and Nat. Hist. Survey of Minnesota 3.

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americana) and the burr oak *(Quercus macrocarpa).* If these species occur, the writer did not observe them. The author is quite sure that the white ash *(Fraxinus americana)* does not occur in the region. I am quite certain that the species barely extends into Minnesota. Arthur, Holway and Bailey do not report this ash in the list of plants between Lake Superior and the International Boundary.

C. R. Van Hise and C. K. Leith who discuss the geology of the Lake Superior region state that the lakes of the region are generally parallel to the trend of the ridges and generally longer than broad.

***U. S. Geol. Survey LII 1911:92

Carrying Capacity of Ranges in Western United States

R. L. HENSEL, B. S. F.
In Charge, Santa Rita Range Reserve.

Few persons realize the importance, necessity and far reaching results of proper range management. There was a time on the Western ranges when 2 or 3 acres of grass land would support a cow or horse. At the present time, 20 to 30 acres per head are needed on the same area. Had the stockman of those days applied some of the principles his neighboring farmers were applying, perhaps unknowingly, he would have maintained the productivity of the range and would have benefited the present generation in lower beef prices. However, let it be said in defense of the cattleman of that day, he was only human. Perhaps anyone seeing the wonderful and abundant forage which covered the West, would have been prompted with the same "get-rich-quick" motives and have exploited the range to its capacity and over and then left the future to care for itself. Years after the ranges were overstocked, state legislatures passed various laws concerning the grazing of stock on public ranges and finally, with the creation of National Forests, many ranges came under the more rational systems now being used by the Forest Service. In a way, it is safe to say that the methods of handling stock are still in their infancy and are still extensive although some of them are called "intensive."

Carrying capacity may be roughly defined as being the number of stock that a range can carry without any depreciation in amount of forage. Indeed, at the present time it goes farther. The aim not only is not to have any depreciation in amount of forage but to try to increase the amount up to the point where it rightfully belongs. To do this there are several factors which enter into the discussion. They are:

Accessibility or nearness to water.
Topography.
Length of time range can be grazed.
Character of vegetation.
Economic conditions nearby.
Diseases and natural foes.

Regardless of how abundant the forage is or how palatable, it has no value unless there is water within reasonable distance. This distance varies in different regions and is affected by the humidity of the air to a very large extent. In Oregon cattle will not travel very readily over about 3 miles to water. In

southern Arizona cattle have been known to travel over 13 miles to water and this every 36 hours in a climate that is exceedingly torrid. It is quite possible to have water so located that all parts of a range will be equally fed, but this is very seldom the case. Usually the intensity of grazing decreases with increase of distance from water. Water is as essential as feed itself. Very often stock will eat plants near water that they will not touch at a greater distance from water. For instance, sheep will eat hellebore near watering places and bedding grounds, but they would not touch it at some distance or where other forage is present. In connection with the discussion concerning water it might be well to state that more and more the importance of good, pure water is coming to be realized. Many stockmen even warm the water in the winter. The older stockmen seemed to think that as long as mud and muck was thin enough to drink it was good enough for any kind of stock.

A level plain would represent an ideal grazing ground to the novice, but here again there is room for argument. A level plain, provided that the yearly temperatures were agreeable and that enough forage and area were available to rotate the different parts, would approach the ideal, but a plain with nearby high mountains forms the best range. On the Wallowa National Forest in Oregon differences in elevation ranged from 900 feet to almost 10,000 feet with corresponding vegetation. This really forms an ideal system, for stock can graze the low elevations in winter and gradually move up towards higher elevations as the snow melts and then return when the first snow falls in the autumn. Of course, there are some drawbacks to this system, but they cannot be enumerated here. However, the point that should be emphasized in this paragraph is this—regardless of whether there is feed and water, the range cannot be used if it is not accessible. Take a case of a mountain side covered with the best of grasses and with abundant water, but beset with steep cliffs and slides for a part of its area so that stock could not safely use it. Until trails and driveways are built, it would be largely a waste range. Very often there are ranges that would make good forage for one class of animals while another would starve. This would be true of goat ranges; sheep or horses or even cattle would starve to death on some goat ranges. This then would be considered an inaccessible forage, if there were no goats to feed it. To get the full forage value and carrying capacity out of a piece of range, then, one must consider its accessibility.

In the warmer parts of this country there are yearlong ranges. That is, grasses and weeds are accessible to stock in winter as well as in summer. This, then, makes the harvesting of crops to feed in the winter unnecessary as is the case when snow

covers the ground for a large part of the winter. It does bring in a similar condition and that is, having some forage to be consumed during the winter. This can be done by fencing off an area or cutting down the number of animals so that enough forage will be on hand to carry them through the winter. If this is not done a condition will prevail which exists in this particular section at present. No reserve food supply was or ever is left and when a dry, cold winter comes and is followed by a late spring, cattle losses are heavy. To overcome such a system, a series of pastures can be put in and "rotated" like the Iowa and Illinois farmer rotates his fields and crops. In the case of the Wallowa National Forest, there were 4 classes of ranges, although only 2 were recognized—winter and summer. To these could be added spring and fall. In a case of this kind the summer range period would last not over 2 months, while the spring and fall periods would probably be the longest, depending on the season. One year in eastern Oregon the season consisted of 2 months spring and 10 months winter.

Character of vegetation determines the kind of stock that can best use the range. For instance, sheep will eat hackberry and thrive on it. Horses and cattle will barely eat it unless forced to. Therefore, it would be a waste of forage to try to make cattle and horses feed on hackberry range when sheep will eat it readily. The same holds true of coarser grasses. Sheep are careful about what they eat. They prefer tender shoots and flowers. They eat grasses but do not care for coarser ones, especially when they are dried or "cured." Now, cattle and horses are fond of grasses and eat cured grass as readily as green. Under proper conditions they do better on dried grass than on green. Therefore, if there is a range that is at its best in the fall and is composed of coarse grasses, it should be fed to cattle and horses —while green and tender it can be lightly grazed by sheep. When possible, the range should be so arranged that the right class of stock uses the range best suited to that class of animals.

Under economic conditions nearby, there should be considered the activities that persons living near any particular piece of range are engaged in. For instance, several large farmers living next a piece of range, have each several head of cattle and horses. The range might be better sheep range, but these men do not have enough stock to warrant moving them on to regular cattle range, so they are put on the wrong class of range adjoining their ranches. Very often this makes necessary a large waste of forage, for it takes more acres of sheep range to run a cow than it does to run a corresponding number of sheep. Also a small sheep man living in a cattle country wants his sheep to range near his ranch, so he runs his sheep in the cattle range. As he gets more sheep and can keep a herder, he may very likely move his stock to a sheep range.

Most stock are susceptible to some disease or other and steps must be taken to prevent their occurrence and spread. In connection with cattle some excellent preventatives have been used. For blackleg many stockmen are now using vaccine and their losses have been cut down noticeably. The very best of ranges are not immune from some diseases and in order to obtain the maximum carrying capacity, measures must be taken to prevent their spread. Very often these diseases are communicated to man as, for example, the "Mountain fever," which is so fatal to man and which is transmitted by ticks. Among natural foes are coyotes, wolves and lions. In one region it was impossible to raise colts for 13 years because mountain lions were so abundant. In the southwest wolves bother stockmen appreciably despite the efforts of the Biological Survey to eradicate them. Coyotes create considerable havoc with sheep and goats, often killing them merely for the pleasure they derive from it and not through necessity. It will be easily understood how a range on which predatory animals are abundant will affect the carrying capacity. Under this heading we may also include poisonous plants. Many are doubtless aware that the Forest Service posts conspicuous warnings in badly infested areas. On one range alone 40 head of cows were counted that had died of poisoning, and the end was not yet in sight. This condition was affecting the carrying capacity by making it necessary to remove the stock to other areas. If nothing is done, it will be necessary to consider the area as waste, inaccessible or undesirable range, or put on some class of stock that is immune to this particular plant.

After having taken the foregoing points into consideration, the amount of forage present must be known and from this can be determined how many animals the area will carry. This is rather a cut and try affair. In a short while the maximum carrying capacity for a range can be determined. When stock are properly watered, salted and distributed, it is possible to increase the carrying capacity from 10 to 100 per cent. Ten per cent may seem a small figure. However, when it is considered that in 1914 there were 1,508,639 cattle on forest ranges and add 10 per cent, giving an increase of 150,863, which at $30.00 per head for yearling yields a monetary increase of over $4,500,000, it is an item worth while. In some cases a 10 per cent increase may mean only a cow or 2 on an allotment, nevertheless, they all represent dollars and cents.

At the present time the Forest Service has experiments started in which problems in carrying capacity and range management are being studied in detail. Range reconnaissance is nothing more than a step toward increased capacity and more efficient range management. It would be impossible for one, in the short space allotted, to go into the very large number of points which come up in a grazing reconnaissance or in the making of a graz-

ing working plan. On the Santa Rita Range Reserve the plans cover about 20 typewritten pages and there are only about 32,000 acres to deal with. The plan here is essentially one in which the forage is allowed to mature its seed before stock are permitted to graze it. In this way the continuance of the present stand of forage is assured and the natural reseeding is provided for by allowing plants to go to seed.

In conclusion, the writer feels safe in saying that the next 10 years will see a great change take place in the method of handling stock on public ranges. This change will originate with the Forest Service and in time will be voluntarily taken up on private holdings.

A Summer's Work on a Forest Service Experiment Station

A. S. HENRY, B. S. F.

The question often comes up in the mind of the student of Forestry, as to what branch or phase of his profession he will specialize in. During the last few years the growth of Forestry as a profession has been rapid and from the comparatively limited field of a few years ago, it has developed into an occupation of many and broad possibilities. The lumberman is coming to see that his timber supply will become exhausted unless closer utilization is practised. The steam and electric railroads and the telephone and telegraph companies are beginning to realize the great saving that will be effected by the use of preservative treated wood. The cities are becoming aware of the value of their park and shade trees and the necessity of conserving them. The Government Forest Service attracts perhaps more men of the forestry profession than does any other single field of activity. One of the most important as well as interesting branches of Forest Service work is that carried on at the various Government Experiment Stations.

A field season spent in practical work gives a student an opportunity to judge of the possibilities his training offers. A summer spent on experimental work gives one a glimpse of the value and economic application that such work has. The Utah Experiment station, located near Ephraim, Utah, on the Manti National Forest, is typical of this kind of work.

It seems to be the accepted view of some, who view the forest from a lumber producing standpoint solely, that the grazing industry is a necessary evil, rather than one of great importance. That this idea is erroneous can readily be seen, from the fact that approximately one-half the revenue derived from the forest service is secured from grazing fees.

The live stock industry is one of the main sources of wealth in the locality of the Utah Experiment Station. The Manti National Forest forms the summer range for a large number of sheep and cattle. The lumber industry is of less importance, the revenue received from grazing fees much exceeding that obtained from timber sales.

Before this region was converted into a national forest reserve, it was grazed as were many other localities in the western country, ruthlessly and with no thought of the future value of the range. Each owner was desirous of securing the best grazing ground for his flock of sheep and the consequent struggle which ensued

was detrimental not only to the stock but to the range as well. The inevitable result of this practice was that the range became overgrazed. It was to remedy this state of affairs that this section of the country was made into a forest reserve.

In order to determine how best to restore the depleted range, experimental studies were begun. The studies are carried on in what is known as the spruce-fir type at an elevation of from 8,000 to 10,000 feet. The top of the ranges are well rounded and are covered with vegetation. The areas where experimental studies are carried on are places that have been overgrazed in the past. Vegetative reproduction is less vigorous here and as a result much erosion has taken place.

Restoration of the range to its original productive capacity with the least economic loss from non-use is desired. This, as shown in the "Natural Revegetation of Range Lands Based Upon Growth Requirements and Life History of the Vegetation," by A. W. Sampson, is best secured by the deferred system of grazing, "which aims at a rotation in the time of using each portion of the range, each year allowing an area to reach seed maturity before it is cropped, but grazing after that period, in order to avoid loss of forage through non-use and to assist reproduction by trampling in the seed." In carrying out this policy grazing is restricted from the areas upon which experiments are carried on until August 20, when the seeds of most of the forage plants have ripened. Revegetational studies to best determine the method of retaining the valuable forage plants, which are the first to disappear when overgrazing is practiced, are made. These studies include a life history study of the most important forage plants.

The collection of a plant herbarium is carried on in connection with this work. The plants are collected as they reach maturity. Three specimens of each species are collected. One specimen is kept for the Experiment Station, one for the supervisor's herbarium and one specimen is sent to the Washington office. In collecting specimens the following points are observed: (1) date of collection; (2) botanical name; (3) common name; (4) exact locality where collected; (5) altitude; (6) slope; (7) soil character; (8) associated species; (9) classes of stock grazing the plant as forage; (10) value as a forage plant; (12) abundance; (13) distribution.

At an elevation approximately the same as where the experiments are carried on, climatological records are kept. These include a daily record of the temperature secured from a thermograph and the variations in temperature by the maximum and minimum thermometers. Readings are made of the soil temperature at 6, 12 and 18 inches, of the humidity, of the evaporation and of the wind velocity. The amount of precipitation and ex-

tent of sunshine each day are recorded. A correlation between these factors and plant growth may then be drawn.

The San Pete valley, into which Ephraim canyon opens, is dependent for its water supply, to grow its crops, upon the water that flows down from the mountains above. A large part of this moisture comes from the snow, which melts off slowly during the summer and maintains a constant supply. The success of the farm crops is dependent upon a plentiful supply of moisture during their growing period. Wherever a forest cover is removed from a steep slope the result will be heavy erosion and frequent floods. The removal of the forest cover allows the moisture to run off rapidly and very little of it is able to find its way into the soil. A vegetative cover will tend to check erosion in the same manner as does the humus and litter in a forest floor. Overgrazing will cause a less dense vegetative ground cover.

In order to afford a comparison between the amount of run-off and erosion upon a grazed and ungrazed area, experimental plots, typical of the locality, are grazed for a number of years. During that time a complete record is kept of total precipitation, rain and snow, and the amount of run-off and erosion. All the precipitation that falls on these experimental areas flows over a weir where it is recorded by means of a float and gage. The sediment settles to the bottom of receiving tanks where it is measured. At the end of a certain interval the area will be closed from grazing and the records continued. A comparison of the results secured will show the value of a vegetative cover in preventing erosion and heavy floods.

About all the timber in this region important from an economic standpoint is found between 5,500 to 9,000 feet in elevation. Between these elevations are included three of Merriam's climatic zones; namely the Upper Sonoran zone, the Transition zone and the Canadian zone.

The Upper Sonoran zone (*Pinon cedar type*) extends from 5,540 to 6,500 feet in elevation. The characteristic flora of this type is pinon pine (*Pinus edulis*), western yellow pine (*Pinus ponderosa*) found along the stream courses, single leaf pinon. (*Pinus monophylla*), two junipers (*Juniperus utahensis*) (*Juniperus scopulorum*), narrow leaf cottonwood (*Populus angustifolia*), scrub oak, (*Quercus Gambellii*), sagebrush (*Artemesia tridentata*), rabbit brush (*Chrysothamnus nauseosus*).

The Transition zone (Oak type) extends from 6,500 to 7,500 feet. The important species are western yellow pine, Colorado blue spruce (*Picea Parryana*), Douglas fir (*Pseudotsuga taxifolia*), white fir (*Abies concolor*), Rocky Mountain birch (*Betula fontinalis*), maple (*Acer grandidentatum*), scrub oak, bitter brush

(*Purshia tridentata*), manzanita (*Arctostaphylos uva-ursi*) and mountain mahogany. (*Cercocarpus parvifolius.*)

The Canadian zone (Douglas fir type) lies between 7,500 and 9,000 feet. The important plants of this zone are Douglas fir, White fir, Colorado blue spruce, balsam fir (*Abies lasiocarpa*), common juniper (*Juniperus communis*), limber pine, (*Pinus flexilis*), quaking aspen (*Populus tremuloides*), *Acer grandidentatum,* Rocky Mountain maple (*Acer glabrum*), chokecherry (*Prunus melanocarpa*), wolfberry (*Symphori carpos occidentalis*) and mountain maple (*Pachystima myrsinites*).

Coniferous plantations are located in various parts of these zones. They are planted in different sites and on different soil with varying conditions of shade. Examinations of these are made one in the Spring and one in the Fall. The examination consists in plotting the species on a chart and noting the number living, dead or missing, their condition, weak or vigorous and the amount of growth the preceding season.

Aspen and coniferous reproduction studies, seed collection, nursery work, collecting soil samples, collection of an herbarium, the laying out of sample experimental plots and other special studies are some of the other phases of experimental work.

A field season spent at experimental work is a profitable one. It is instructive because it requires close application and a regard for detail. It serves to develop originality in treating with unexpected problems and it is interesting because of the very nature of the work itself.

Directory of Forestry Alumni

Allen, E. L.—ex '17. Coeur d'Alene, Idaho.
Blackwell Lumber Company.
Allen, Shirley W.—'09. Syracuse, New York.
University Extension, New York State College of Forestry.
Atkins, J. W.—ex '19. Columbia, South Dakota.
Balthis, R. F.—'07. Flagstaff, Arizona.
Deputy Forest Supervisor, Coconino National Forest.
Barrett, R. L.—'11. Koshkonong, Missouri.
Superintendent, Co-operative Orchard.
Baxter, W. G.—'08 (Yale). Aspen, Colorado.
Forest Supervisor, Sopris National Forest.
Baxter, L. J.—'13. Galva, Iowa.
Stock Farm Operator.
Beam, Donald S.—ex '20. U. S. Army.
Coast Artillery.
Betts, E. G.—ex. '15. Winner, South Dakota.
Montgomery Lumber Company.
Board, Lynn—ex '19. Hudson, Iowa.
Bode, I. T.—'15. Hays, Kansas.
Foreman of Forest Nursery, Fort Hays Branch Experiment Station.
Brown, D. K.—ex '13. Harlan, Iowa.
Associate Editor, Shelby County Republiican.
Cassidy, Hugh O.—'16. Mimbres, New Mexico.
Ranger, U. S. Forest Service.
Cornell, H. H.—'16. 2089 Carter Ave., St. Paul, Minn.
St. Paul Park Service.
Clark, H. B.—'13. Sioux City, Iowa.
Cronin, L. J. Sibley, Iowa.
Dallmus, Karl—ex '19. Strawberry Point, Iowa.
Evans, John H.—ex '18. State Center, Iowa.
Feltus, Van M.—ex '17. Correctionville, Iowa.
Freeman, F. G.—ex '11. Santa Ana, California.
Santa Ana Wholesale Grocery Co.
Geisler, Max—'16. St. Louis, Missouri.
Missouri Botanical Gardens.
Haeffner, H. E.—'08. Grants Pass, Oregon.
Forest Examiner, Siskiyou National Forest.
Hansel, Harry—'15. Ottumwa, Iowa.
Assistant County Engineer.
Harley, W. P.—'15. Mescalero, New Mexico.
Forest Examiner, U. S. Indian Service.
Hassel, W. C.—'14. Ely Minnesota.
Assistant Ranger, Superior National Forest.
Hawcott, Wm.—ex '18. U. S. Army.
Aviation Corps.
Hayes, R. W.—'14. Ashland, Wisconsin.
Forest Assistant, U. S. Indian Service.
Hensel, R.—'13. Tucson, Arizona.
U. S. Forest Service.
Hesner, Harold—ex '19. Strawberry Point, Iowa.
Hess, George—ex '19. Washta, Iowa.
Hicks, L. E.—'15. Afton, Wyoming.
Assistant Forest Ranger.
Hoffman, A. F.—'11. Pagosa Springs, Colorado.
Forest Examiner, San Juan National Forest.

Horton, F. V.—'13. Pendleton, Oregon.
U. S. Forest Service.
Hughes, Andrew—ex '19. Boone, Iowa.
Iowa National Guard.
Ineck, C. H.—ex '16. Prescott, Arkansas.
Isch, D. H.—ex '17. West Bend, Iowa.
Jones, G. C. —'16. Charles City, Iowa.
Teaching High School.
Koepke, W. C. Information wanted.
Kupfer, C. A.—'07. San Francisco, California.
Forest Examiner, Products Division, District Office.
Lent, Archie—ex '19. Valparaiso, Indiana.
Valparaiso University.
Lessel, L. R.—'10. Payson, Arizona.
Ranger, U. S. Forest Service.
Lorenzen, H. A.—ex '17. Le Mars, Iowa.
Martin, R. G.—ex '19. U. S. Army.
Aviation Corps.
Mast, W. H.—'00 (Yale '05). Davenport, Iowa.
Davenport Nursery work.
McCarthy, C. C.—'16. U. S. Army.
Coast Artillery.
McGrew, T. M.—ex '19. Cloquet, Minnesota.
Lumber Camp No. 16.
McCullough, T. E. (Yale). Flagstaff, Arizona.
Forest Examiner, Coconino National Forest.
Merritt, M. L.—'04. 405 Beck Bldg., Portland, Oregon.
District Office, Improvements. U. S. Forest Service.
Morris, R. D.—'16. Goshen, Indiana.
Nagel, W. M.—'14. St. Marys, Idaho.
Planting Reconnaissance, St. Joe National Forest.
O'Banion, A. C.—'12. Glyndon, Minnesota.
Olmstead, R. A.—'12. Dundee, Oregon.
Pammel, Harold—ex '20. U. S. Army.
Coast Artillery.
Parks, L. S. Phoenix, Arizona.
Agriculture Inspector, U. S. Reclamation Service.
Petheram, H. D.—ex '16. Cass Lake, Minnesota.
Plagge, H. H.—'16. Barrington, Illinois.
Plagge, N. O.—'16. Barrington, Ill.
Ray, F. C. Des Moines, Iowa.
Ray Coal Company.
Reynoldson, L. A.—'11. Primghar, Iowa.
Richmond, H. H.—'12. Cass Lake, Minnesota.
Forest Assistant, Minnesota National Forest.
Ringheim, H. I.—'12. Dumblane, Saskatchewan, Canada.
Manager of Retail Lumber Yards.
Rumbaugh, W. R.—'16. Ottumwa, Iowa.
Phelps Landscape Company.
Sage, H. H.—'15. Information wanted.
Schmidt, H. O.—ex '17. Renville, Minnesota.
Schreck, R. G.—'14. Ely, Minnesota.
Superior National Forest.
Schultz, F. M.—ex '19. U. S. Army.
Aviation Corps.
Smith, R. P.—'15. Information wanted.
Smith, W. A.—'12. Ogden, Utah.
Superintendent of Canning Mill.

Smith, P. T.—'11. Deadwood, South Dakota.
Forest Examiner, Black Hills National Forest.
Steffen, E. H.—'13. Wallowa, Oregon.
Forest Examiner, Wallowa National Forest.
Stokes, Ralph—'16. Coeur d'Alene, Idaho.
Blackwell Lumber Company.
Sterrett, J. C.—'14. Raymond, Washington.
Yard Foreman, Willapa Lumber Company.
Van Boskirk, S. S.—'14. Santa Fe, New Mexico.
Watts, L. F.—'13. Afton, Wyoming.
Forest Examiner.
Warner, D. H.—ex '19. 1315 Filmore St., Des Moines, Iowa.
Webber, Burr S.—ex '19. U. S. Army.
Coast Artillery.
Weldin, Neil—ex '18. U. S. Army.
Whitham, J. C.—'11. Camp Crook, South Dakota.
Supervisor, Sioux National Forest.
Wiewel, Ronald—ex '19. Rolfe, Iowa.
Wilcox, H. F.—ex '13. Quincy, California.
Ranger, Plumas National Forest.
Wilkins, J. P.—ex '19. Monticello, Iowa.
Wolfe, E. T.—'14. Du Bois, Wyoming.
Asst. Forest Ranger, Bonneville National Forest.
Wolven, R. M.—'14. Worthington, Minnesota.
Hardware and Timberman's Supply Store.
Holmes, A. E.—ex '16. Sioux City, Iowa.
Quint, J. H.—'16. Escanaba, Mich.
Tie Treating Plant, C. & N. W. Ry.

Seven Thousand Miles With Ames Foresters

G. B. MACDONALD, M. F.
Professor of Forestry, Iowa State College.

The 1917 summer trip taken by the Ames forestry students was made through Iowa, Nebraska, Colorado, Utah, Nevada, California, Oregon, Washington, Idaho, Montana, North Dakota and Minnesota. The class was in the field for 12 weeks under the direction of 3 members of the forestry faculty. The students had an opportunity to observe the principal timber types in all the important lumber regions of western United States as well as to make detailed studies of logging and milling operations. During the trip 3 Forest Service Experimental Stations, several nurseries, and 14 National Forests were visited. The trip was made at a relatively small expense to the students. Camps were established at the different stops and, except in a few cases, meals were served in camp.

The Forest Service officials of the many National Forests visited went out of their way to be of service to the class—which made the trip both pleasant and profitable.

The following shows the schedule of the trip:

June 7—Left Ames.

June 8—Arrived at Denver, Colorado. After an hour the class left for Palmer Lake. A walk of 4 miles brought the class to the Monument Nursery, where several hours were spent looking over the nursery operations under the charge of Mr. Schrader.

June 8-10—Arrived at Manitou in the evening and made camp near the "cog station." The first day was taken up with a trip on foot to the Fremont Experiment Station, where the class was given the details of the experiemntal work carried on at the station by Mr. Nelson, in charge. The second day was spent by most of the party in walking to the summit of Pike's Peak.

June 11-15—Red Cliff, Colorado. The stay here was spent in making silvicultural, mill, and logging studies. Forest Ranger Gustaffson piloted the class to the interesting points on the forest. Camp was established just outside the town and the various members of the class tried camp cooking for the first time.

June 15—Glenwood Springs, Colorado. A stop between trains was made and the class enjoyed a swim in the big hot spring plunge.

June 16. Soldiers Summit, Utah. A stop of one day here enabled the class to take a silvicultural and dendrological trip through the timber of that locality.

June 17. Salt Lake City, Utah. The interesting points of the city were visited during a few hours stop between trains.

June 18. En route through Nevada.

June 19-20. Portola, California. This stop of two days was made on the eastern border of the Plumas National Forest in the Yellow Pine country. Forest Ranger Nail was detailed to assist the class at this point. Studies were made of the timber and of the milling and logging operations of the Feather River Lumber Company.

June 21-27. Quincy, California. At this stop the Feather River experiment station was visited. Some work in fighting a forest fire was experienced. The class was taken over the forest by Supervisor Rogers and Forest Examiner Taylor. Interesting observations were made on reproduction and management.

June 28-29. Los Angeles, California. A day spent in sight seeing.

June 30-July 1. Redwood Park, California. Parts of two days were spent on a hiking trip from Boulder to Redwood Park. Here a fine grove of large redwoods was seen.

July 2. San Francisco, California. The day was taken for seeing the city.

July 3-7. Sisson, California. Under the guidance of Supervisor Hammitt observations were made of planted areas. A trip was made to the top of Mt. Eddy, where a modern lookout was established.

July 8-10. Cottage Grove, Oregon. Two days were taken in the vicinity studying logging operations of a large lumber company.

July 11. Portland, Oregon. A stop over night was made at the "Rose City."

July 11-30. Wind River Nursery, Carson, Washington. This was the longest stop of the trip. Camp was made at the Wind River Nursery where good bunk houses and a modern mess house were put at the disposal of the camp. Detailed studies were made of the large nursery. A splendid opportunity was afforded to study the timber types of the Northwest. The operations of the Wind River Lumber Company were also studied. A timber estimate was made, fire plans studied and much information was gathered on the experimental work of the Wind River Experiment Station. Mr. Hofman, in charge of the station, and Ranger Cline gave the class valuable assistance.

July 30. Columbia and Portland. The trip from Carson to Portland was made by boat.

July 31. Oregon City and Portland. A part of the day was spent in the big mill of the Willamette Paper Company.

August 2-5. Sultan to Index, Washington. Under the piloting of Ranger Mortimer the class took a 70 mile inspection trip

through the Snoqualmie National Forest. Near Index a modern logging operation was visited.

August 5. Spokane, Washington.

August 6. Coeur d'Alene, Idaho, to St. Maries, Idaho.

August 7-12. Fernwood, Idaho. Visited the box mill and saw mill of the Milwaukee Railroad. Several days were spent at Camp 16 of the Blackwell Lumber Company.

August 12-14. Flume Construction camp between Fernwood and St. Joe, Idaho.

August 15. Spent in an overland hike from camp to St. Joe and St. Maries.

August 16. St. Maries to Coeur d'Alene, Idaho, by boat.

August 17. Spokane, Washington.

August 18. Libby, Montana. A day was spent in the saw mill of the Libby Lumber Company. Supervisor Smith, of the Kootenai National Forest served as guide to the class.

August 19-23. Glacier National Park. The class took a 4-days hiking trip through Glacier Park, looking from Belton to Glacier Park Station, by way of Lake MacDonald, Gunsight Pass, Piegan Pass and Many Glaciers. The 4-days hike covered 115 miles.

August 24. En route to Cass Lake, Minnesota.

August 25-28. Cass Lake, Minnesota. Four days were spent on the Minnesota National Forest on silvicultural, planting, nursery and mill studies. Forest Supervisor Marshall and Forest Examiner Richmond assisted at this stop.

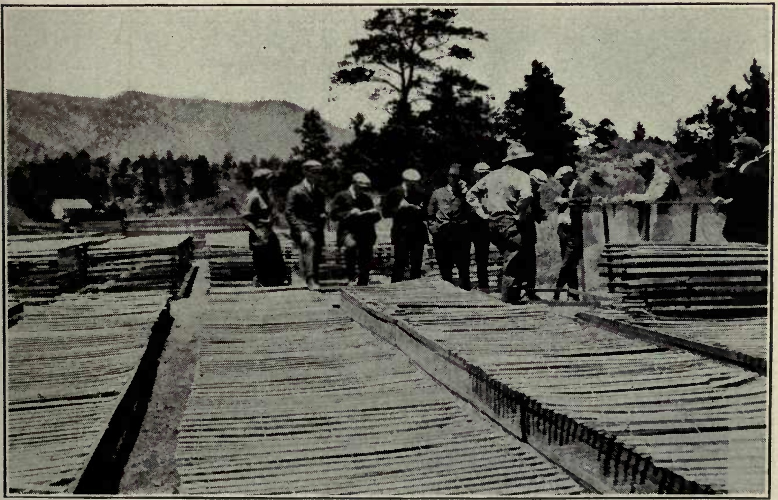
August 29. Cloquet, Minnesota. The mill of the Great Northern Paper Company was visited, and a trip was made to the Cloquet Experiment Station, under the direction of Mr. Kenety.

August 30. Duluth, Minnesota.

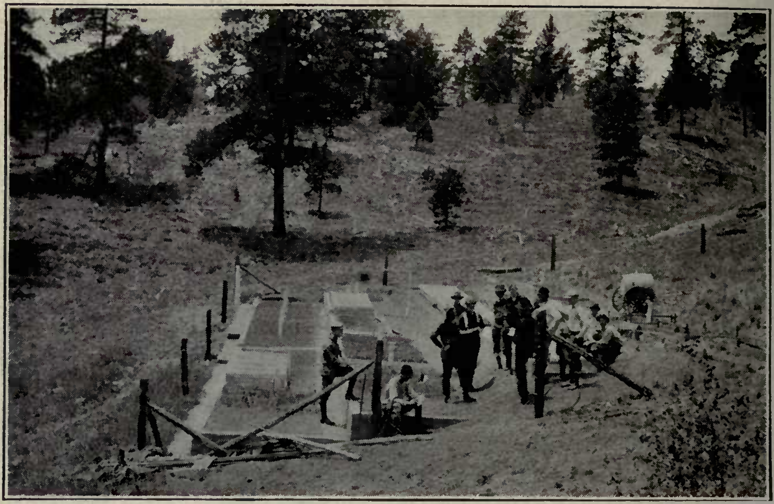
August 31. Minneapolis, Minnesota.

September 1. Ames, Iowa.

The Ames forestry class on the first stop of the Western trip, at the Forest Service Nursery at Monument, Colorado. At this point the class had an opportunity to look over the nursery operations of the Forest Service in this region.



The Ames foresters making a detailed study of the Forest Nursery at Monument, Colorado. Mr. Schrader, the nursery foreman, is explaining the seed-bed methods to the class.



The forestry class at the experimental nursery at the Fremont Experiment Station in Colorado.

The class making camp on arrival at Soldiers Summit, Utah.

Ames foresters making reproduction studies in yellow pine, and Jeffrey pine on the Plumas National Forest in California.

Taking notes on logging on the Plumas National Forest, California.

The foresters making a study of the logging methods in the California woods.

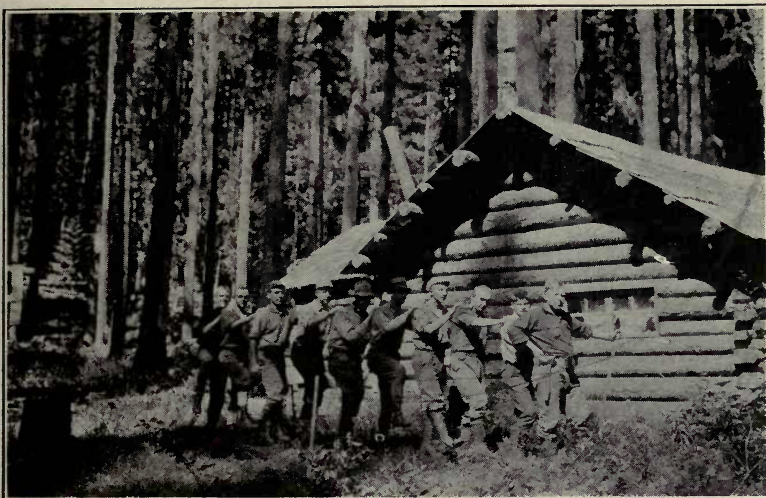
The class at the Forest Lookout Station on Mount Eddy, in California. Here the class had an opportunity to look over detailed fire protection plans.

The Ames foresters in action, cutting fire wood for the camp, Wind River Experiment Station, Columbia National Forest in Oregon.

The class taking lessons in shake making on the Columbia National Forest, Oregon.

The class in the woods at Cottage Grove, Oregon.

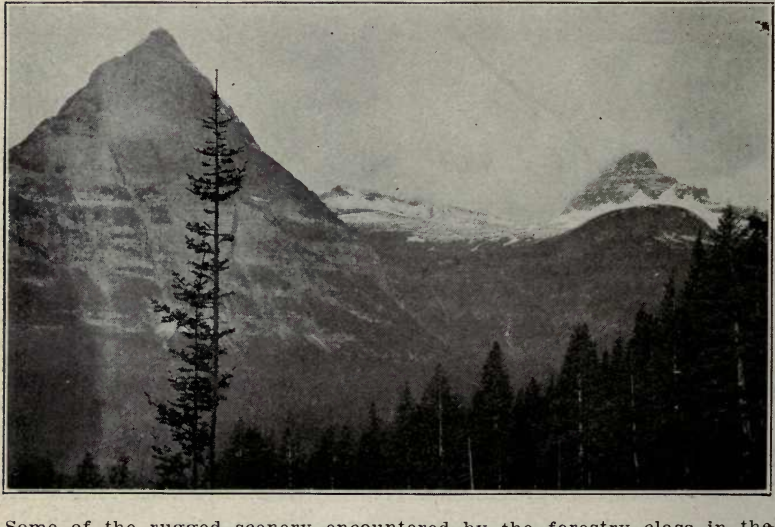
Leaving the Columbia National Forest by way of the Columbia River, Portland.



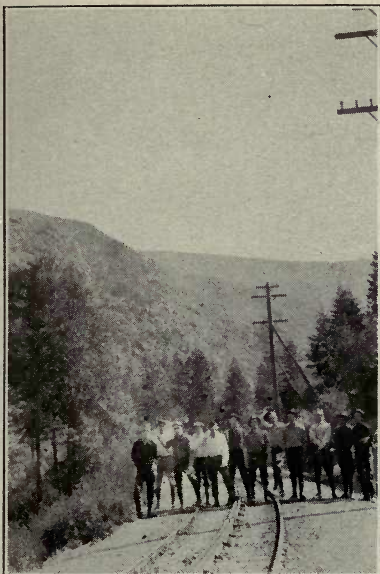
Lined up for a timber estimating trip in northern Idaho in the famous Western white pine region.

A view of Piegan Pass, Glacier National Park. One of the many beautiful views seen on the 115-mile hiking trip through this park.

A part of the Ames forestry class on the Minnesota National Forest.

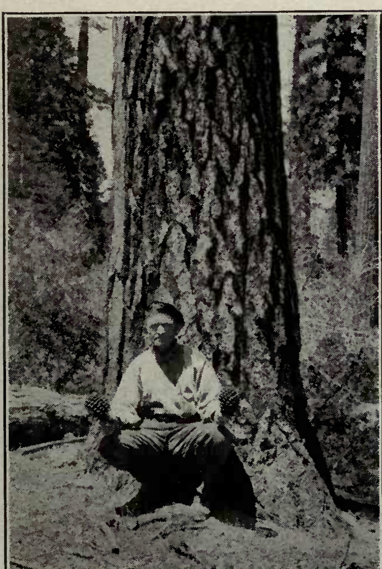


Some of the rugged scenery encountered by the forestry class in the Glacier National Park, Montana.



The foresters on their way to the Fremont Experiment Station on the slopes of Pike's Peak.

A portion of the class on an inspectic trip on the Plumas National Fore in California. In the center is show a Jeffrey pine tree.

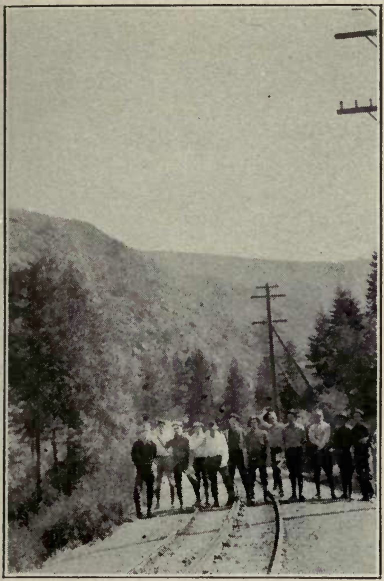


Forest Ranger Nail, who served as guide for the forestry class on an inspection trip on the Plumas National Forest at Portola, Californi The picture shows Jeffrey pine bark

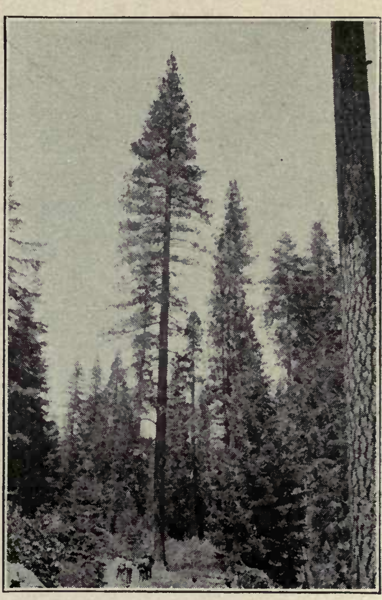
A pause in the Redwood State Par California, where the class had a opportunity to observe some of th largest trees in the country.

A part of the Ames forestry class on the Minnesota National Forest.

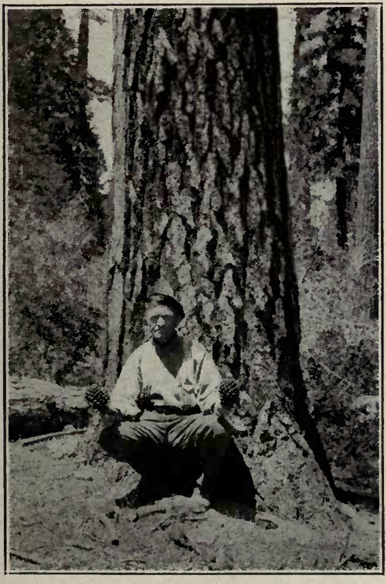
Some of the rugged scenery encountered by the forestry class in the Glacier National Park, Montana.



The foresters on their way to the Fremont Experiment Station on the slopes of Pike's Peak.



A portion of the class on an inspectic trip on the Plumas National Fore in California. In the center is show a Jeffrey pine tree.



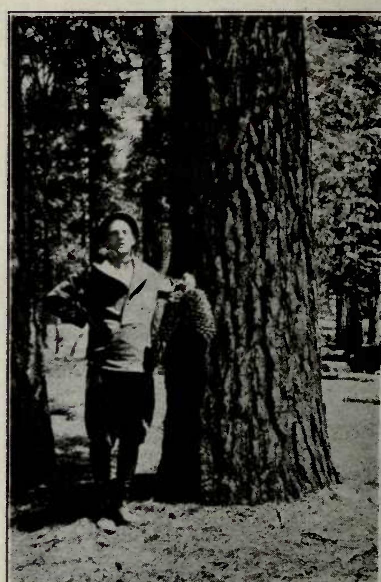
Forest Ranger Nail, who served as guide for the forestry class on an inspection trip on the Plumas National Forest at Portola, Californi The picture shows Jeffrey pine bark

A pause in the Redwood State Par California, where the class had a opportunity to observe some of th largest trees in the country.

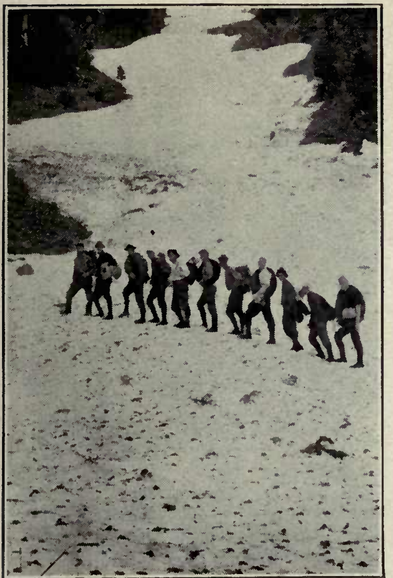
A short stop was made at Big Tree Station, California. Here the class had an opportunity to see some fine redwood timber. The high redwood stump shown in the picture has two thrifty sprouts each over a foot in diameter.

In the Pacific Northwest the forestry class had an opportunity to study in detail some of the largest sawmills in the country. The picture shows the Jack ladder in the big Weyerhauser Mill at Everett, Washington.

A portion of the class on a timber cruise on the Columbia National Forest in Washington. Tree shown is Douglas fir.



During the Western trip the forestry class had a splendid opportunity to study at close hand practically all of the important commercial timber trees of the West. The picture shows



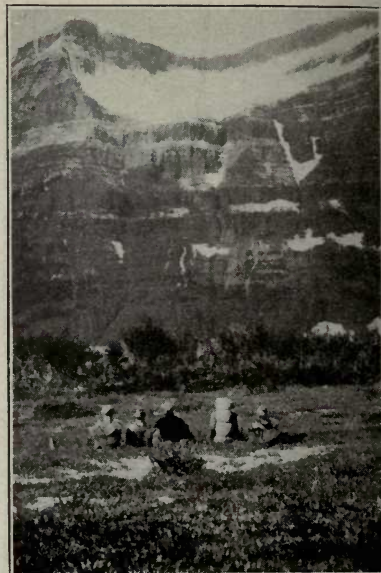
The class on an inspection trip through the Snoqualmie Forest in northern Washington. The trip is in charge of Forest Ranger Mortimer.

Some of the rugged scenery encountered by the forestry class on the overland trip through the Snoqualmie National Forest. A burnt-over area in the foreground.

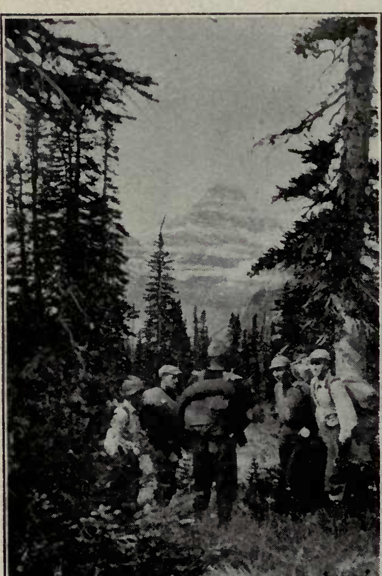
Professor Truax, Forest Ranger Mortimer, of the Snoqualmie, and Ames foresters, waiting on the Great Northern at Index, Washington.

The class making an inspection of a Lidgerwood log skidder on an operation of the Blackwell Lumber Company, Idaho.

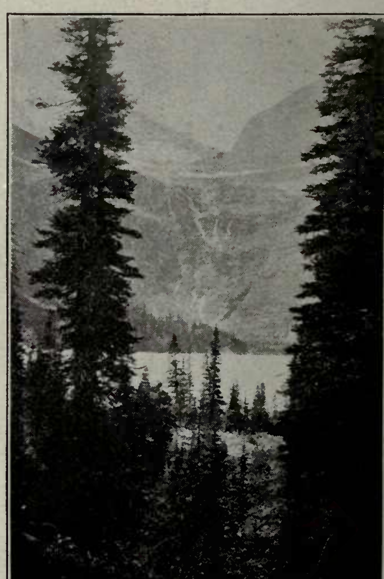
During the Western trip the forestry class had an opportunity to see the finest stands of the famous Western white pine in the United States. A Western white pine specimen taken on the St. Joe Forest in northern Idaho.



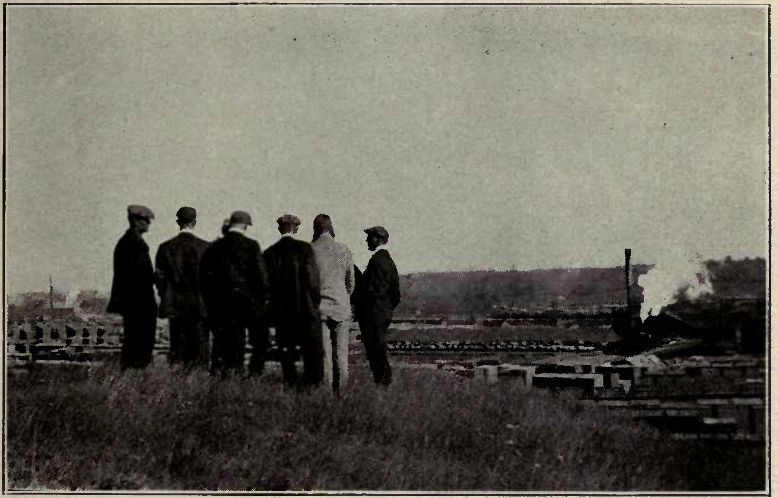
On the Glacier Park hiking trip. View shows a hanging glacier.



Some Alpine scenery on the Glacier Park hiking trip.



View on the trip from Piegan Pass to Many Glaciers in Glacier National



A part of the forestry class at the big lumber center in Cloquet, Minn.

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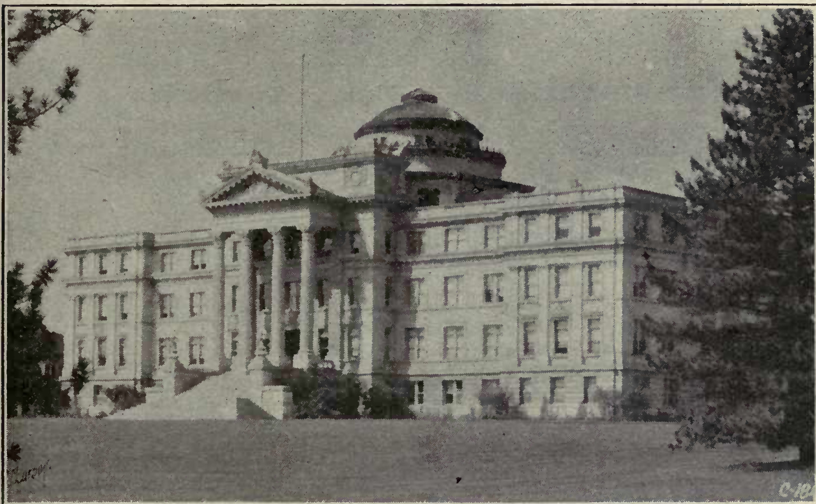
OFFICIAL PUBLICATION OF
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

Vol. XV | MAY 1, 1917 | No. 35



CENTRAL BUILDING

ADMISSION
AND
COURSES OF INSTRUCTION

Ames, Iowa

Published Tri-Monthly by the Iowa State College of Agriculture and Mechanics Arts. Entered as Second-class matter at the Post Office at Ames, Ia., under the Act of Congress of August 24, 1912.

COLLEGE CALENDAR

(Subject to change)

1917-1918

FIRST SEMESTER

September 6-7, Thursday and Friday, 8:00 A. M.	Entrance Examinations.
September 10-11, Monday, 8:00 A. M., to Tuesday, 5:00 P. M.	Registration-Classification Days.
January 25, 1917, Friday, 12:00 M.	First Semester Closes.

SECOND SEMESTER

January 31-February 1, Thursday and Friday, 8:00 A. M.	Entrance Examinations.
February 4-5, Monday, 8:00 A. M., to Tuesday, 5:00 P. M.	Registration-Classification Days.
June 6, Thursday, 10:30 A. M.	Commencement.
June 10-August 29.	Summer School.

FACULTY SUMMARY

President, Deans	7
Professors	45
Associate Professors	61
Assistant Professors	46
Instructors	130
Assistants, Fellows, Scholars	64
Agricultural Experiment Station	54
Engineering Experiment Station	23
Agricultural Extension	47
Engineering Extension Work	9
	486
Less Duplicates	45
Total	441

CENTRAL BUILDING AND MORRILL HALL

STATE BOARD OF EDUCATION

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John E. Foster, *Inspector of Secondary Schools*................Des Moines

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Edgar Williams Stanton, M. S., LL. D....................................
Vice President, Secretary and Dean of the Junior College
Charles Franklin Curtiss, M. S. A., D. S. Dean of the Division of Agriculture
Anson Marston, C. E...................Dean of the Division of Engineering
Charles Henry Stange, D. V. M....................................
Dean of the Division of Veterinary Medicine
Catharine J. MacKay............Dean of the Division of Home Economics
R. E. Buchanan, M. S., Ph. D.....Dean of the Division of Industrial Science
Herman Knapp, B. S. A...........................Treasurer and Registrar
Thomas Sloss....................Superintendent of Buildings and Grounds
Mrs. Emily Cunningham.............................Advisor to Women

The Iowa State College

ADMINISTRATION

The laws of the State of Iowa provide for the management and control of the State College of Agriculture and Mechanic Arts by the State Board of Education. This board consists of nine men nominated by Governor and confirmed by the Senate. This board appoints a finance committee consisting of three men, who give their entire time to the management and control of the four state educational institutions of Iowa, under such rules and regulations as the State Board of Education may prescribe.

SCOPE OF INSTRUCTION

The Iowa State College of Agriculture and Mechanic Arts seeks to aid young men and women in the acquirement of a higher technical education. Instruction is given in the sciences, together with such experimental work as to enable the students successfully to engage in a practical profession. Throughout the several courses, the study of the text-book is supplemented by lectures, discussions, library work, and practical and experimental work in the laboratory. The instruction is mainly practical, the student verifying and putting into practice in the laboratory the instruction received in classes.

The Iowa State College offers two six-year courses, eleven five-year courses, eighteen four-year courses, two two-year collegiate courses, nine non-collegiate courses, twelve-weeks Summer School, and one-week Winter Short Courses.

LOCATION

The College occupies a delightful and healthful location upon high, rolling land in the west part of Ames, Story County. Situated at the junction of the north and south branch and the main double-track line of the Chicago & Northwestern Railroad, and connected with all the trunk lines of Iowa, Ames is easily accessible from all parts of the State. An electric railway connects Ames and the College with efficient service. The Fort Dodge, Des Moines and Southern Railway (electric), with stations on the campus, gives efficient service to the College, and excellent connections with the following trunk lines in Iowa: At Fort Dodge, with the Illinois Central and Chicago Great Western; at Huxley, with the Chicago, Milwaukee & St. Paul; at Des Moines with the Chicago, Rock Island & Pacific, the Chicago Great Western, and the Chicago, Burlington & Quincy.

Ames is a most desirable town for wholesome college influences. Its people are thrifty, enterprising, and cordial. The town has an excellent system of public schools, numerous churches, waterworks, and electric lights, and it also has a good city government. It is an inviting community for families who wish to educate their children and to enjoy a good environment at a reasonable expense. Ames and the College are on very cordial terms,

and its citizens seek to promote the efforts of the students and the highest interests of the College.

THE COLLEGE GROUNDS

Of the entire College domain of 1,342 acres, 125 acres are set apart for college grounds. These include the experimental plots, the young forestry plantations, the surroundings of the professors' dwellings, and the central campus with its beautiful winding walks and drives; its trees, shrubbery, and flower gardens and its large and stately college buildings. The true principles of landscape gardening have been so faithfully observed in the gardening and in the location of buildings and drives as to make the entire campus a large and beautiful park.

BUILDINGS

Fifty commodious buildings, besides the dwelling houses and the buildings for farm stock, machinery, and work, have been erected by the State for the exclusive use of the various departments of the College. All of these buildings are heated by steam, lighted by electricity, and supplied with pure water.

EMPLOYMENT BUREAU

The Y. M. C. A., located in Alumni Hall, maintains a students' employment bureau to aid students in obtaining work to defray, in part, their college expenses.

The Deans of the different divisions of the College also find employment for as many of their students as possible.

ALUMNI HALL

ADMISSION TO THE COLLEGE

The applicant for admission should request the principal or superintendent to forward to the Registrar a complete transcript of his high school or preparatory school record, showing the number of weeks and hours per week spent upon each study, with the grades received. Credential blanks may be secured upon application at the Registrar's office. Upon receipt of the credentials the Registrar will notify the applicant with regard to his admission and will send directions for registration.

All official high school records should be filed with the Registrar at the close of the school year, if possible, and not later than the second Monday in August or the first Monday in January.

REQUIREMENTS FOR ADMISSION TO THE SEVERAL DIVISIONS OF THE COLLEGE

Applicants for admission to the Freshman class should be at least sixteen years of age.

The requirements for admission are stated in terms of units. An entrance unit is defined as thirty-six weeks of high school work in one subject of study, with five class periods per week, each not less than forty minutes in length. Each laboratory period should be at least eighty-five minutes in length. Students desiring admission to the freshman year must present fifteen units. Of these, certain units are required and the balance may be elective.

GROUPS	Division of Agriculture Units	Division of Engineering Units	Division of Home Economics Units	Division of Industrial Science Units	Division of Veterinary Medicine Units
1. English	3	3	3	3	3
2. History-Civics-Economics	1	1	1	1	1
3. Foreign Language*.....	...	2	2	2	...
4. Mathematics					
Algebra 1½		1½	1½	1½	1½
Plane Geometry...1	} 2½	1 } 3	1 } 2½	1 } 2½	1 } 2½
Solid Geometry...		½	...	...	...
5. Natural Sciences.......	...	...	...	...	...
6. Additional requirements in the above groups 1, 2, 3, 4 and 5: of these groups two must have 3 units each, and the five groups must have a minimum total of 11 units..........	4½	2	2½	2½	4½
	11	11	11	11	11
7. Electives	4	4	4	4	4
Total units required for admission	15	15	15	15	15

*In the Divisions of Engineering and Industrial Science the two required units must be in one foreign language. In the other divisions the students are urged to meet this standard.

**A student may enter by meeting either the old or the new requirements until he registers for the year 1919, when the new requirements will be in full force.

Conditional Admission

A student who presents fourteen (14) acceptable units may be conditionally admitted to the Freshman year. He shall be classified in the deficient work as a part of the normal amount of work allowed to students, and must remove the condition before classification for the second year's work. Students will not be permitted to remove entrance conditions by taking an entrance examination in any subject which they have pursued in the College.

Exception to this rule: In case a student presents fifteen (15) acceptable entrance units, not including foreign language (where foreign language is required) he shall be conditioned in foreign language and may postpone the making up of the condition until the beginning of the Junior Year, when he will be classified in the subject. To remove the condition, if taken in College, it will require extra work to the extent of five hours per week for two semesters.

List of Subjects

Entrance units may be allowed as indicated below, subject also to the table on page 6 as to the amount of any subject which can be used toward the fifteen units. No credit is to be given for less than one-half unit in any single subject.

Group 1. English.

(1) A total of not more than 4 units, including the required 3 units. Not less than 3 semesters in literature, and 3 semesters in composition, rhetoric and grammar; provided that no credit will be given for grammar if taken before the eleventh grade.

Group 2. History, Civics and Economics.

(1) A total of not more than 4 units, including the required unit, and not more than the maximum credit here indicated in each case; provided that no credit will be given for United States history if taken before the eleventh grade.

(a)	Ancient history	½ to 1 unit
(b)	Medieval and modern history	½ to 1 unit
(c)	English history	½ to 1 unit
(d)	United States history	½ to 1 unit
(e)	General history (but not in addition to medieval and modern history)	1 unit
(f)	Civics	½ to 1 unit
(g)	Political economy	½ unit

Group 3. Foreign Language.

(1) A total of not more than 4 units in any one foreign language, including the required 2 units. No credit is to be given for less than one unit in any foreign language.

(a)	Greek	2 to 4 units
(b)	Latin	2 to 4 units

(c)	French	2 to 4 units
(d)	Spanish	2 to 4 units
(e)	German	2 to 4 units
(f)	Scandinavian	2 to 4 units

Group 4. Mathematics.

(a)	Algebra (required)	1½ units
(b)	Plane geometry (required)	1 unit
(c)	Solid geometry	½ unit
(d)	Plane trigonometry	½ unit
(e)	Advanced Algebra	½ unit
(f)	Advanced Arithmetic (no credit can be given for arithmetic unless taken in the third or fourth year of the secondary school course or after the completion of 1½ units in algebra)	½ unit

Group 5. Natural Sciences.

(1) A total of not more than 4½ units will be accepted in this group.

(a)	Agriculture Plant Industry Animal Industry General Agriculture Rural Economics	½ to 2 units
(b)	Astronomy	½ unit
(c)	Biology, elementary	½ to 1 unit
(d)	Botany	½ to 1 unit
(e)	Chemistry, not less than	1 unit
(f)	General Science	½ to 1 unit
(g)	Geology	½ unit
(h)	Physical Geography or Physiography	½ to 1 unit
(i)	Physics, not less than	1 unit
(j)	Physiology	½ unit
(k)	Zoology	½ to 1 unit

Group 6. Additional Required Work (see table above).

Group 7. Electives. Whatever work to the extent of four additional units the accredited school certifies as accepted by that school for graduation; subject to the definitions of units of entrance credit adopted by the North Central Association of Colleges and Secondary Schools, or in bulletins published by the Iowa Board on Secondary School Relations. A total of not more than 4 units will be accepted in commercial, industrial, and miscellaneous subjects.

(1) Commercial subjects.

(a) Business arithmetic (not in addition to advanced arithmetic, and only if taken

	after the completion of the required 1½ units in algebra or in the latter half of the high school course)	½ unit
(b)	Elementary bookkeeping	½ to 1 unit
(c)	Advanced bookkeeping	½ to 1 unit
(d)	Commercial law	½ unit
(e)	Stenography and typewriting	1 to 2 units
(f)	Business correspondence	½ unit
(g)	History of commerce	½ unit
(h)	Economic history of England	½ unit
(i)	Economic history of United States	½ unit
(j)	Materials of commerce	½ unit
(k)	Commercial geography	½ unit

(2) Industrial subjects.

(a)	Freehand or Mechanical Drawing	½ to 2 units
(b)	Manual Training, i. e., shop work	½ to 4 units
(c)	Domestic Science	½ to 2 units

(3) Miscellaneous.

(a)	Public speaking	½ unit
(b)	Bible	½ to 1 unit
(c)	Music	½ to 2 units
(d)	Agriculture—additional units	½ to 2 units
(e)	Psychology	½ to 1 unit
(f)	Pedagogy and methods	½ to 1 unit

METHODS FOR OBTAINING THE FIFTEEN UNITS

There are four methods of obtaining the necessary units for admission to the Freshman class:

A. Admission by transfer from other colleges and universities.
B. Admission by certificate from fully accredited high schools.
C. Admission from unaccredited high schools.
D. Admission by examination and on other evidences of proficiency.

Admission from Unaccredited High Schools

A student presenting a certificate from an *unaccredited* school may be admitted to collegiate courses by the following plan:

(1) He is to pass entrance examinations in acceptable subjects representing each of the main groups of subjects certified, for one-third of the number of acceptable credits so certified.

(2) The subjects for examination are to be selected by the college examiner at the time of the examination and irrespective of the choice of the student.

During the month of May the Inspector of Secondary Schools for the State Board of Education, Des Moines, Iowa, sends to the Superintendents of the unaccredited high schools of Iowa for their supervision the entrance examination for the applicants who desire admission to the three state institutions. All papers, together with the examination questions used, should be sent to the Inspector.

In case the student fails in one or two groups of the subjects he may take another examination at the regular time set for the examinations in September and at the institution to which the student seeks admission.

(3) The total number of credits ultimately allowed on the certificate shall not exceed three times the number earned by examination.

(4) The total amount of credit gained in this way, together with *additional* credit for subjects not indicated in the certificate (or subjects so indicated, but not acceptable), if additional credit is needed, shall be at least fourteen (14) units. In case he presents less than fifteen (15) acceptable entrance units he is to be conditioned to the extent of enough units to bring the total number up to fifteen (15) units.

Entrance Examination Program

The scope of the entrance examinations is indicated in the "General Statement Concerning Entrance Units," pages 6 to 10.

Admission to the entrance examinations is by permit. Permits may be obtained of the Registrar, Room 125, Central Building.

A representative from each department will conduct the examinations in Room 102, Central Building, on Thursday and Friday preceding classification.

Any student finding a conflict in his program should report to the Registrar for adjustment.

Graduates of the unaccredited schools of the State should take the entrance examinations in May according to the instructions set forth on page 9.

Thursday—

Algebra	8-10 A. M.
Plane Geometry	8-10 A. M.
English	10-12 A. M.
Latin, first year	1- 3 P. M.
Latin, second year	1- 3 P. M.
German, first year	1- 3 P. M.
German, second year	1- 3 P. M.
Botany	3- 5 P. M.

Friday—

Algebra	8-10 A. M.
Solid Geometry	8-10 A. M.
History, General	10-12 A. M.
History, American	10-12 A. M.
History, English	10-12 A. M.
Civics	1- 3 P. M.

Physiology	1- 3 P. M.
Physiography	1- 3 P. M.
Physics	3- 5 P. M.
Latin, first year	3- 5 P. M.
Latin, second year	3- 5 P. M.
German, first year	3- 5 P. M.
German, second year	3- 5 P. M.

The Registrar will arrange for the other entrance examinations required by the candidates for admission.

ADVANCED STANDING

Students of other colleges will be admitted to advanced standing in this college under the following conditions:

First, they must present a letter of honorable dismissal.

Second, the entrance requirements to the college must be fully satisfied (see admission from other colleges under Entrance Requirements).

Third, students of other colleges will be admitted and granted such credits as their work will justify. Work of recognized merit that has been taken at colleges and universities of good rank and standing will be credited for an equivalent amount of work so far as it applies in any of the courses offered at this college. Students taking up work in this way will present official records to the Advanced Standing Committee at the Registrar's office to ascertain the credits to be allowed. It will be understood between the applicant and the Committee that the credits are only provisionally accepted and that their final acceptance depends wholly upon the student maintaining a good average standing for one year in Iowa State College.

Fourth, it is required that all credits from other institutions be sent by the proper officers of such institutions, duly certified, to the Registrar of this College, such certificates to include the number of weeks the student has pursued the studies in question and the number of hours' credit received in each semester, as well as the portion of the subjects covered.

Fifth, advanced or college credit may be given for extra high school or secondary school work only on the following conditions:

1. The number of units reported and accepted must be in excess of 16.
2. There must be a *rigorous* examination for college credit.

STATE TEACHERS' CERTIFICATES

Graduates of the Iowa State College of Agriculture and Mechanic Arts, who have completed six hours in psychology and fourteen hours in education are granted a first-grade state teachers' certificate without examination. The present course in agricultural education makes provision for this work in psychology and education as a required part of the course. A first-grade state certificate is valid upon registration in any county for five years and is renewable.

Graduates of the college who have not completed the requirements for a first-grade certificate are granted a third-grade state certificate by the Educational Board of Examiners. Anyone expecting to enter teaching, even temporarily, is urged to secure full information with reference to certificates by inquiry from the head of the department of agricultural education. The requirements for certificates are gradually being raised, not only in Iowa, but in surrounding states, and information as to requirements is kept available.

SPECIAL STUDENTS

Students taking special work in any of the College courses must be at least twenty-one years of age, must give good and satisfactory reasons for desiring such classification, and must furnish satisfactory evidence that they are thoroughly prepared to pursue the work chosen. Permission to take such special course and the subjects included therein depends upon the approval of the President of the College and the Dean or Head of the Department in which the student seeks enrollment.

Permission to take a special course will not be granted to students until they have completed the Freshman year of some one of the courses offered, and then only for a period not to exceed two years. Exceptions to the regulation requiring the completion of the Freshman year, and to the rule limiting the special course to two years, will be made in case of persons of mature years who desire to take a particular line of scientific or technical work, and whose application to take such course is approved by the Faculty of the Division in which the student seeks enrollment, and by the President of the College.

Special students are subject to the same rules governing conditions on back work as apply to all other students. The standard prerequisites for advanced work are subject to limited modification with the approval of the Dean of the Division in which the student is classified. A student wishing to change from a regular to a special or irregular course, either in the same or another department, will not be permitted to change from one course to another if he has a condition or a not pass in a subject not common to the two courses; or if he has more than one condition or not pass in subjects common to the two courses. Special students, as well as regular students, are subject to the conditions given under Requirements for Admission.

It is the theory of special classification that students should be particularly strong and well prepared to do thorough work in the studies they elect. A high standard of scholarship will, therefore, be required of all who are thus classified.

Graduates of approved colleges, who are not candidates for a degree, may take special work in this institution under the rules governing special students, without having to complete the Freshman year in any of the college courses. Permission to take such special courses and the subjects included therein depends upon the approval of the President of the College and the Dean or Head of the Department in which the student seeks enrollment.

IRREGULAR COLLEGE STUDENTS

Worthy persons in good standing over twenty-one years of age, not prepared to meet the entrance requirements of the Freshman year, may be admitted without examination, as irregular college students, and may pursue college work not to exceed two years, provided:

1. That they give evidence of satisfactory preparation to carry such work successfully.

2. That they show good and sufficient reasons for not taking a regular course.

3. That they present a certificate covering their **entire** preliminary education.

4. That they be required to obtain written permission from the President of this College to register as an Irregular Student. Such students will then be registered, classified and dealt with the same as regular College students.

For non-collegiate courses, see page 41.

FEES AND EXPENSES

The entire expenses of a student need not exceed $400.00 per year at the College.

Honor Scholarships: The State Board of Education has provided one honor scholarship for each accredited high school in the state. This scholarship represents the same value in cash whether presented at the State College or at one of the other state institutions. It is worth $20.00 for the year, and at the State College this amount will be allowed on fees.

As soon as any school has made its nomination for the scholarship, the school authorities are expected to report the name and address of the nominee, together with a signed certificate of scholarship, to the State Inspector of Secondary Schools, State Board of Education, Des Moines, Iowa, who will approve the nomination if the conditions have been met, and forward the proper credentials to the candidate, sending the certificate of credits to the institution elected.

Nominations should be made in June, and must be made not later than August 1st of each year.

Tuition: The Code of Iowa reads as follows: "The tuition in the College herein established shall be forever free to pupils from the state over sixteen years of age, who have been residents of this state six months previous to their admission."

To the non-residents a tuition fee of $25.00 per semester is charged.

Tuition Scholarships: The form of Tuition Scholarships is intended only for those students from states other than Iowa, who, without such aid, cannot secure a college education. The conditions on which this aid is granted are as follows: (1) The applicant must be in need of financial assistance; (2) the applicant must be of good moral character; (3) the applicant must

give evidence of good preparation; (4) the recipient must give evidence of ability by good standing in one of the regular courses leading to the bachelor's degree.

The aid which is given from the Tuition Scholarships Fund is not regarded as a loan. If, however, a student who receives this aid is able to return the amount in later years, it will be credited to his accounts on the books of the College Treasurer, and the sum, whatever it may be, will be put into the Tuition Scholarships Fund of the College for the use of future students.

All applications for these scholarships must be made on the uniform blanks furnished by the President.

The time of filing applications with the Chairman of the Tuition Scholarship Committee, in order to secure consideration, is as follows:

First Assignment—not later than October fifteenth.

Second Assignment—not later than January fifteenth.

All Freshmen and other first-year students will be considered only at the second assignment unless one semester's work has already been completed at the College.

Thirty-eight tuition scholarships are available; eight to each collegiate class; two to sub-collegiate students; and four to students from foreign countries.

The applicant must be considered a member of the class indicated by his classification at the Registrar's office.

Payment of the tuition scholarship to the recipient will be made as follows: The amount of the first semester's tuition ($25.00) will be placed to the credit of the recipient with the College Treasurer when the scholarship is awarded; and the amount of the second semester's tuition ($25.00) will be placed likewise—only, however, when the recipient has completed his registration for the second semester. The payment of scholarships awarded at the second assignment may be made, as stated above, but in one amount ($50.00) when the student has completed his registration for the second semester.

If the tuition has been paid by the recipient before a scholarship was awarded him, that amount, either a part or a whole, equivalent to the scholarship assigned, will be refunded by the College Treasurer.

Renewal of tuition scholarships will be made from year to year only upon the presentation of a new blank. In no case is this aid granted for more than one year, unless the applicant is re-entered in the competition and rewarded a scholarship.

NOTE.—Prospective Freshmen should carefully consider the cost of the first year. No one should think of entering college unless he has money enough in his own right or from friends to meet his expenses in large part for his Freshman year. If he goes out of his Freshman year in debt he is quite sure to be seriously embarrassed for the remainder of his college course. Provision should be made to meet college bills with the same business-like promptness with which one expects to meet other bills.

Incidental and Janitor Fees: The regular incidental and janitor fee for the semester is $9.00 for all students who complete their classification during

the regular classification period, Monday and Tuesday. Beginning with the first day on which classes are held the fee for college students will be $12.00 plus $1.00 additional for each day thereafter until the classification is completed. This fee is used as follows: Hospital, $2.00; students' repair fund, $1.00; incidental and janitor service, balance.

Laboratory Fees: Laboratory fees at the actual cost of breakage and usage are charged to the students, the Treasurer's receipt for such fee being required before the students are admitted to laboratories. For the amount of the fee in any study, see descriptive studies in index of general catalog.

Board and Room: About three hundred and twenty-five young women can secure rooms in Margaret Hall and the new dormitories. Students rooming in these buildings will be furnished with bed, mattress, rug, chairs, dresser and table. Students will furnish bedding and such other articles as they need.

The price for rent, heat and light will be from $8.00 to $16.00 per month for the double rooms, according to the size and quality of the room. The room rent will be for the semester. Each semester's rent is payable in advance at the Treasurer's office. In case of failure to take the room after making the deposit, the student will forfeit $10.00. There are twenty single rooms. In the other rooms two persons will divide the rent. The Advisor to Women reserves the right to assign two persons to each room if necessary.

All young women rooming in dormitories on the campus are required to board at the boarding halls of their respective dormitory. All other students can secure furnished room and board in clubs or private families adjacent to the college grounds at $5.75 per week.

In order that undesirable rooms and houses may be avoided, all young women students are required to secure rooms through the Advisor to Women and the young men students should consult the Secretary of the Young Men's Christian Association, Alumni Hall, Ames, Iowa. For sanitary or other reasons the college authorities reserve the right to forbid students from rooming in any particular house.

No group of young women students may establish a "house" or "home," nor make any definite plans in such direction, without the full knowledge and approval of the President and the Advisor to Women. No young woman may become a resident of a sorority house until after she has been initiated into the sorority.

For the information of students, clubs, and interested private families the Committee on Student Accommodations has prepared standard regulations to assist in the management of houses which furnish room or board to students. These regulations are for the use of members of the instructional and clerical staffs and other members of the college community when reference to standard practice is desirable. Houses accommodating both students and others who are not students are expected to observe regulations for houses accommodating students. Copies of these regulations may be secured from the President's office, the Y. M. C. A. Secretary, or the Chairman of the Committee on Student Accommodations.

Text Books: All text books and stationery may be purchased at the College Book Store at about 20 per cent below the average retail price.

Diploma Fee: A diploma fee of $5.00 is payable before graduation.

Certificate Fee: A fee of two dollars ($2.00) is charged for the final certificate issued upon completion of all non-collegiate courses.

Freshman Expenses

Taking into consideration the items named under "Expenses" the following is an approximate estimate of the expenses of a Freshman for each of the two semesters of the college year:

	Minimum Amount	Maximum Amount
Board (18 weeks)	$ 72.00	$ 90.00
Room rent (18 weeks—basis of two in a room)	27.00	36.00
Laundry	9.00	12.50
Incidental and Janitor Fee	9.00	12.00
Laboratory Fees	15.00	25.00
Books and Equipment	19.50	45.00
	$151.50	$220.50

For engineering students, the minimum estimate should be increased fifteen dollars, under Books and Equipment, for drawing instruments and material.

In addition to these items at the beginning of the Freshman year the men students will have to purchase a military suit at $14.50 (subject to market changes) and a gymnasium suit for $3.95; and the women students, a gymnasium suit for $7.00. The students are also advised to purchase a students' activity ticket and to pay class dues, which items would amount to about $6.00 for the entire year.

The military and gymnasium suits and drawing equipment will be serviceable for the entire course.

If a student is a non-resident of the state $25.00 per semester should be added for tuition.

The incidental and janitor fee, laboratory fees, books and equipment, five-dollar deposit for military suit, gymnasium outfit, and some payment toward room rent and board are required to be paid in advance.

List of Courses

COLLEGIATE COURSES

COURSE IN AGRICULTURAL EDUCATION

Leading to the degree of Bachelor of Science in Agricultural Education.

FRESHMAN YEAR

First Semester
Shop Work, Market Types of Cattle and Sheep, General Chemistry, Corn Production, Farm Dairying, General Horticulture, Library Instruction, Algebra and Trigonometry, Military Drill, Gymnasium Work.

Second Semester
Shop Work, Market Types of Dairy Cattle, Horses and Swine; General Chemistry and Qualitative Analysis, Farm Forestry, Small Grains, Graphic Methods, Plant Morphology, Mechanics, Heat and Light; Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Organic Chemistry, Narration and Description, Military and Physical Culture, Outlines of Psychology, General Zoology, Electives.

Fourth Semester
Exposition, Military and Physical Culture, Educational Psychology, Electives.

JUNIOR YEAR

Fifth Semester
Methods, Weeds or Plant Embryogeny, Agricultural Economics, Soil Physics, Electives.

Sixth Semester
Principles of Education, Soil Fertility, Farm Management, Electives.

SENIOR YEAR

Seventh Semester
Training in Teaching Agriculture or Home Economics, Extempore Speech, Electives.

Eighth Semester
Methods and Practice Teaching in Agriculture or Home Economics, Extempore Speech, Electives.

*To procure upon graduation a state teacher's certificate without examination the student must elect from the Departments of Psychology and Agricultural Education, not less than twenty hours of such work as will meet the requirements of the State Board of Educational Examiners. See page 11.

COURSE IN AGRICULTURAL ENGINEERING

Leading to the degree of Bachelor of Science in Agricultural Engineering.

FRESHMAN YEAR

First Semester
Shop Work, Technical Lecture, General Chemistry, Narration and Description, Corn Production, College Algebra, Plane Trigonometry, Mechanical Drawing, Military Drill, Gymnasium Work.

Second Semester
Shop Work, Technical Lecture, Market Types of Dairy Cattle, Horses, and Swine; General Chemistry and Qualitative Analysis, Exposition, Plane Trigonometry, Analytical Geometry, Projective Drawing, Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Farm Machinery, Quantitative Analysis, Surveying, Calculus, Military and Physical Training, General Physics.

Fourth Semester
Farm Motors, Surveying, Calculus, Mechanics of Engineering, Military and Physical Training, General Physics.

JUNIOR YEAR

Fifth Semester
Advanced Shop Work, Seminar, Farm Motors, Rural Sanitation, General Horticulture, Mechanics of Engineering, Engineering Laboratory, Soil Physics, Electives.

Sixth Semester
Seminar, Farm Structures, Materials of Construction, Farm Dairying Small Grains and Forage Crops, Hydraulics, Engineering Laboratory, Soil Fertility.

SENIOR YEAR

Seventh Semester
Seminar, Irrigation, Animal Feeding, Hydrology, Roads and Pavements, Agricultural Economics, Specifications and Contracts, Argumentation or Literature, Industrial History of the United States or Economic History of Agriculture, Landscape Gardening, Electives.

Eighth Semester
Seminar, Thesis, Drainage Engineering, History of Engineering, Farm Management, Landscape Gardening, Machine Work, Electives, Practical Experience.

Five-Year Course in Agricultural Engineering

Leading to the degree of Bachelor of Science in Agricultural Engineering.

The five-year course includes all of the work given in the four-year course and in addition the following technical and cultural studies: Agricultural Engineering Research; Graphic Methods; Market Types of Beef Cattle, and Sheep, Small Grain Production; Sewerage; Business Economics; Mechanical Drawing; Heating and Ventilation; Highway Engineering; Water Supply; Sanitary Engineering; Engineering English; Technical Journalism and additional electives.

TWO-YEAR COLLEGIATE COURSE IN AGRICULTURE

A two-year collegiate course in agriculture is offered to students who are qualified to enter the regular four-year college courses, but do not wish to take more than two years of college work. This course is specially arranged for this class of students and meets their needs more satisfactorily than the non-collegiate course, which was established only for those who cannot meet regular college entrance requirements. Permission to enter the two-year collegiate course in agriculture must be secured from the Dean of the Division and the President of the College.

In the first year of the two-year collegiate course the student takes the work prescribed for Freshmen in some one of the departments of the Division of Agriculture. In the second year he continues his study in a major branch, selecting his subjects with the approval of the head of the department concerned or the dean of the division. He may also elect such other subjects as meet the approval of the head of the department or the Dean of the division, providing he can meet the standard prerequisites for that work, limited modifications thereof being granted. The minimum requirement for the two years is 70 credits. The schedule of the course for the entire year is to be made at the beginning of the year and placed on file with the Dean.

On the satisfactory completion of two years of such work the student is granted a certificate giving evidence of that fact. If he decides later to return to complete a full four-year course, he shall receive credit toward his degree for the two-year work already completed.

CORRESPONDENCE STUDY

To those unable to attend classes at the College, but who wish to pursue work of a collegiate grade, the College offers correspondence work in the departments of Agricultural Education, Agricultural Engineering, Animal Husbandry, Dairying, Farm Crops, Forestry, Horticulture and Soils. A fee of $1.00 per credit hour is charged.

The work is open to those who have had the required preparation for admission to the College. See Requirements for Admission, page 6.

For further information address Dean C. F. Curtiss, Division of Agriculture, Ames, Iowa.

COURSE IN ANIMAL HUSBANDRY

Leading to the degree of Bachelor of Science in Animal Husbandry.

FRESHMAN YEAR

First Semester
Shop Work, Market Types of Cattle and Sheep; General Chemistry, Corn Production, Farm Dairying, General Horticulture, Library Instruction, Algebra and Trigonometry, Military Drill, Gymnasium Work.

Second Semester
Shop Work, Market Types of Dairy Cattle, Horses and Swine; General Chemistry and Qualitative Analysis, Small Grains, Farm Forestry, Graphic Methods, Plant Morphology, Mechanics, Heat and Light; Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Breed Types of Cattle and Sheep, Poultry Husbandry, Agricultural Survey, Organic Chemistry, Narration and Description, Military and Physical Training, Anatomy of Domestic Animals.

Fourth Semester
Breed Types of Dairy Cattle, Horses and Swine; Poultry Husbandry, Farm Machinery and Motors, Agricultural Analysis, Exposition, Military and Physical Training, General Zoology.

JUNIOR YEAR

Fifth Semester
Feeding and Management of Live Stock, General Bacteriology, Ecology, Economic History of American Agriculture, Soil Physics, Comparative Physiology, Embryology.

Sixth Semester
Animal Breeding, Feeding and Management of Live Stock, Seminar, Argumentation or Literature of Farm and Community Life, Forage Crop Production, Soil Fertility, Electives.

SENIOR YEAR

Seventh Semester
Advanced Live Stock Judging, Agricultural Economics, Nutrition and By-products, Seminar, Soil Management, Obstetrics, Animal Parasites, Farm Sanitation, Electives.

Eighth Semester
Herd Book Study, Thesis, Beef, Pork, Milk, Mutton and Wool Production; Horse Feeding, Seminar, Soundness and Shoeing, Electives.

DAIRY HUSBANDRY GROUP

For Freshman and Sophomore years, see Animal Husbandry Course.

JUNIOR YEAR

Fifth Semester
Feeding and Management of Live Stock, Soil Physics, Comparative Physiology, Embryology, General Bacteriology, Argumentation or Literature of Farm and Community Life.

Sixth Semester
Animal Breeding, Feeding and Management of Live Stock, Dairy Breeds, Milk Testing and Inspection, Dairy Bacteriology, Soil Fertility.

SENIOR YEAR

Seventh Semester
Advanced Live Stock Judging, Animal Nutrition, Dairy Husbandry, Seminar, Market Milk, History of American Agriculture or Agricultural Economics, General Bacteriology, Soil Management, Obstetrics, Animal Parasites, Farm Sanitation, Electives.

Eighth Semester
Herd Book Study, Thesis, Pork Production, Horse Feeding, Dairy Husbandry, Seminar, Milk Production and Herd Management, Forage Crop Production, Soundness and Shoeing, Electives.

POULTRY HUSBANDRY GROUP

For Freshman and Sophomore years, see Animal Husbandry Course.

JUNIOR YEAR

Fifth Semester
Breed Types of Poultry, Agricultural Economics, Soil Physics, Comparative Physiology, Embryology, General Bacteriology.

Sixth Semester
Animal Breeding, Incubation, Brooding, Poultry Bacteriology, Soil Fertility, Electives.

SENIOR YEAR

Seventh Semester
Nutrition, Animal Feeding, Poultry Seminar, Market Poultry, Farm Sanitation, Animal Parasites, Electives.

Eighth Semester
Thesis, Poultry Feeding, Poultry Seminar, Marketing and Judging Poultry Products, Poultry Research, Diseases and Hygiene, Electives.

Six-Year Course in Animal Husbandry and Veterinary Medicine.

(Administered jointly by the Dean of Agriculture and the Dean of Veterinary Medicine. For plan of the course of study, see general catalog.)

COURSE IN ARCHITECTURAL ENGINEERING

Leading to the degree of Bachelor of Science in Architectural Engineering.

FRESHMAN YEAR

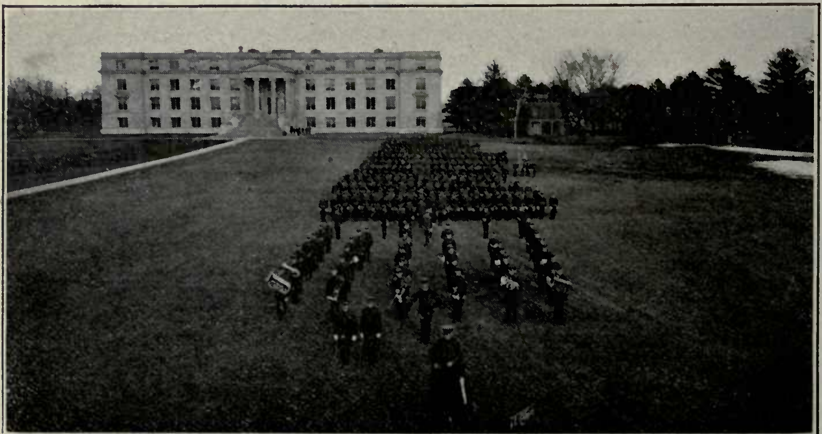
First Semester
Technical Lecture, General Chemistry, Working Drawings, Lettering, Exposition, College Algebra, Plane Trigonometry, Military Drill, Gymnasium Work.

Second Semester
Techical Lecture, Freehand Drawing, Descriptive Geometry, Surveying, Working Drawings, Narration and Description, Plane Trigonometry, Analytical Geometry, Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Elements of Architecture, Freehand Drawing, Field Work, Argumentation, Calculus, Military and Physical Training, General Physics.

Fourth Semester
History, Surveying, Freehand Drawing, Design and Theory of Architecture, Calculus, Mechanics, Military and Physical Training, General Physics.



CADET REGIMENT—COLUMN OF MASSES.

JUNIOR YEAR.

Fifth Semester
Seminar, Freehand Drawing, History of Architecture, Engineering Geology, Materials of Construction, Mechanics of Engineering, Engineering Economics, Laboratory, Small Electric Plants.

Sixth Semester
History of Architecture, Seminar, Farm Structures, Cement and Masonry, Laboratory, Masonry Construction and Foundations, Structural Engineering, Conservation of Natural Resources, Engineering English, Hydraulics.

SENIOR YEAR

Seventh Semester
Fireproof Construction, Heating Design, Seminar, Structural Engineering. Reinforced Concrete, Structures, Heating and Ventilating, Sanitary Engineering, Specifications and Contracts, Illumination.

Eighth Semester
Industrial Structures, Thesis, Contracting, Seminar, Sanitation of Buildings, Advanced Reinforced Concrete, History of Engineering.

COURSE IN CERAMICS

Leading to degree of Bachelor of Science in Ceramics.

FRESHMAN YEAR

First Semester
General Chemistry, Field Work, Exposition, College Algebra, Trigonometry, Drawing, Military Drill, Civil Engineering Field Work, Gymnasium Work, Technical Lecture.

Second Semester
General Chemistry and Qualitative Analysis, Surveying, Narration and Description, Plane Trigonometry, Analytical Geometry, Drawing, Military Drill, Technical Lecture, Gymnasium Work.

Mining Engineering field work—two weeks during summer vacation.

SOPHOMORE YEAR

Third Semester
Quantitative Analysis, Argumentation, Calculus, Drawing, Physical Training and Military Drill, Mining Engineering Journal Club, General Physics.

Fourth Semester
Ceramic Chemistry, Ceramic Calculations, Calculus, Mechanics of Engineering, Physical Training and Military Drill, Journal Club, General Physics.

Mining Engineering field work—two weeks during summer vacation.

JUNIOR YEAR

Fifth Semester
Ceramics Lectures, General Geology, Mechanics of Engineering, Mechanical Engineering, Laboratory, Seminar, Electives, Physics, Laboratory.

Sixth Semester
Ceramics Lectures, Structural Engineering, Engineering English, Conservation of Natural Resources, Mechanical Engineering Laboratory, Seminar, Metallurgy, Physics Laboratory, Electives.

Mining Engineering field work—four weeks during summer vacation.

SENIOR YEAR

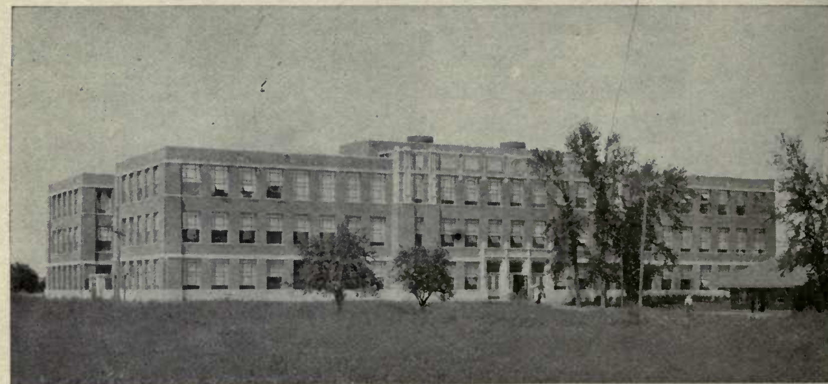
Seventh Semester
Ceramics Design, Ceramics Laboratory, Ceramics, Specifications and Contracts, Geology, Seminar, Electives, Steam Engines and Boilers.

Eighth Semester
Ceramics Laboratory, Ceramics Thesis, History of Engineering, Economics, Geology. Seminar, Electives, Power Plant Engineering.

Five-Year Course in Ceramics

No special five-year course in ceramic engineering is offered, but those students who can afford to spend five years in preparation for this work are earnestly advised to pursue to completion a four-year course in ceramic engineering and then to take an additional year of work in ceramics along some special line, consisting of not less than thirty hours and subject to the approval of the professor in charge of this department.

Such a course would lead to the same degree as the four-year course, and a professional degree will be awarded subject to the same conditions as hold in the five-year engineering courses. By so shaping his course that the extra year of work conforms to the requirements of the Graduate School, the student can obtain a Master of Science degree at the end of the fifth year.



CHEMISTRY HALL

COURSE IN CHEMICAL ENGINEERING

Leading to the degree of Bachelor of Science in Chemical Engineering.

FRESHMAN YEAR

First Semester
Technical Lecture, General Chemistry, Exposition, College Algebra, Plane Trigonometry, Drawing, Military Drill, Physical Training, Scientific German.

Second Semester
Technical Lecture, General Chemistry and Qualitative Analysis, Narration and Description, Plane Trigonometry, Analytical Geometry, Military Drill, Physical Training, Projective Drawing, Scientific German.

SOPHOMORE YEAR

Third Semester
Technical Lecture, Seminar, Quantitative Analysis, Calculus, Argumentation, Mechanical Drawing, Military Drill, Physical Training, Physics.

Fourth Semester
Seminar in German, Quantitative Analysis, Municipal Chemistry, Calculus, Mechanics of Engineering, Military Drill, Physical Training, General Physics.

Chemical Engineering summer shop practice of 170 hours.

JUNIOR YEAR

Fifth Semester
Seminar in German, Chemistry Machinery, Applied Organic Chemistry, Thermodynamics, Engineering English, Mechanics of Engineering, Mechanical Laboratory.

Sixth Semester
Seminar, Industrial Inorganic Chemistry, Applied Electricity, Applied Organic Chemistry, Conservation of Natural Resources, Laboratory, Applied Thermodynamics, Electives.

Seventh Semester
Seminar, Industrial Organic Chemistry, Chemical Manufacture, Applied Electro Chemistry, Applied Physical Chemistry, Specifications and Contracts, Electives.

Eighth Semester
Seminar, Chemical Manufacture, Thesis, Applied Physical Chemistry, Applied Electricity, History of Engineering, Electives.

COURSE IN CIVIL ENGINEERING

Leading to the degree of Bachelor of Science in Civil Engineering.

FRESHMAN YEAR

First Semester
Surveying, Technical Lecture, Drawing, General Chemistry, Exposition, College Algebra, Plane Trigonometry, Military Drill, Physical Training.

Second Semester
Surveying, Engineering Drawing, Technical Lecture, General Chemistry and Qualitative Analysis, Narration and Description, Plane and Spherical Trigonometry, Analytical Geometry, Military Drill, Physical Training.

SOPHOMORE YEAR

Third Semester
Drawing, Seminar, Surveying, Argumentation, Calculus, Military and Physical Training, General Physics.

Fourth Semester
Topographical Drawing, Surveying, Seminar, Physics Laboratory, Mechanics of Engineering, Geodetic Field Work, Calculus, Military and Physical Training, General Physics.

Civil Engineering—summer surveying camp, two weeks.

JUNIOR YEAR

Fifth Semester
Railway Engineering, Cement and Masonry Laboratory, Materials of Construction, Engineering Economics, Engineering Geology, Mechanics of Engineering.

Sixth Semester
Roads and Pavements, Masonry Structures, Seminar, Structural Laboratory, Structural Engineering, Railway Engineering, Conservation of Natural Resources, Hydraulics, Electives.

Civil Engineering—summer surveying camp, two weeks.

SENIOR YEAR

Seventh Semester
Hydraulic Laboratory, Reinforced Concrete Structures, Thesis, Seminar, Structural Engineering, Sewerage, Hydrology, Highway Design, Specifications and Contracts, Engineering English, Electives.

Eighth Semester
Water Supply Engineering, Thesis, Seminar, Structural Engineering, Drainage, History of Engineering, Power Engineering, Electives.

Five-Year Course in Civil Engineering

Leading to the degree of Bachelor of Science in Civil Engineering.

In the five-year course in Civil Engineering the following subjects are offered in addition to those required in the four-year course: Advanced Composition; Industrial History of the United States; History of Modern Europe and the United States from 1763 to 1912; Public Speaking; Extempore Speech; Modern Language; Engineering Economics; Business Law; Technical Journalism; Electric Power; and additional technical and non-technical elective studies. For plan of the course of study, see general catalog.

COURSE IN DAIRYING

Leading to the degree of Bachelor of Science in Dairying.

FRESHMAN YEAR

First Semester
Shop Work, Market Types of Cattle and Sheep, General Chemistry, Corn Production, Farm Dairying, General Horticulture, Library Instruction, Algebra and Trigonometry, Military Drill, Gymnasium Work.

Second Semester
Shop Work, Market Types of Dairy Cattle, Horses and Swine; General Chemistry and Qualitative Analysis, Farm Forestry, Small Grains, Graphic Methods, Plant Morphology, Mechanics, Heat and Light; Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Cheesemaking, Breed Types, Organic Chemistry, Economic History of American Agriculture, Narration and Description, Extempore Speech, Military and Physical Training.

Fourth Semester
Cheesemaking, Milk Testing and Inspection, Breed Types, Agricultural Analysis, Exposition, Agricultural Economics, Extempore Speech, Military and Physical Training.

JUNIOR YEAR

Fifth Semester
Buttermaking, Technology of Milk, Judging Dairy Products, Principles of Breeding, General Bacteriology, Dairy Chemistry, Marketing of Agricultural Products, Electives.

Sixth Semester
Butter Judging, Dairy Bacteriology, Dairy Engineering, Dairy Chemistry, Soil Fertility, Argumentation or Literature of Farm and Community Life, Landscape Gardening.

SENIOR YEAR

Seventh Semester
Ice Cream and Ices, Market Milk, Beginning Technical Journalism, Animal Feeding, Obstetrics, Farm Sanitation, Electives.

Eighth Semester
Seminar, Management of Dairy Plants, Agricultural Advertising, Thesis, Technical Journalism, Milk Production and Herd Management, Forage Crops, Electives.

COURSE IN ELECTRICAL ENGINEERING

Leading to the degree of Bachelor of Science in Electrical Engineering.

FRESHMAN YEAR

First Semester
Technical Lecture, General Chemistry, Exposition, College Algebra, Plane Trigonometry, Mechanical Drawing, Forge, Military Drill, Gymnasium Work.

Second Semester
Technical Lecture, General Chemistry and Qualitative Analysis, Narration and Description, Analytical Geometry, Plane Trigonometry, Projective Drawing, Foundry Work, Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Technical Lecture, Quantitative Analysis, Argumentation, Calculus, Drawing, Pattern Work, Military and Physical Training, General Physics.

Fourth Semester
Technical Lecture, Calculus, Drawing, Machine Shop, Mechanics of Engineering, Military and Physical Training, General Physics.

JUNIOR YEAR

Fifth Semester
Electric and Magnetic Circuits, Engineering Economics, Mathematics, Mechanics of Engineering, Materials of Construction, Mechanical Engineering Laboratory, Physics Laboratory.

Sixth Semester
Direct Current Machinery, Theory of Alternating Currents, Laboratory, Engineering English, Conservation of Natural Resources, Mechanical Engineering Laboratory, Hydraulics, Physics Laboratory.

SENIOR YEAR

Seventh Semester
Alternating Current Machinery, Laboratory, Seminar, Specifications and Contracts, Laboratory, Engines and Boilers or Telephony, Steam and Gas Laboratory, Machine Design, Theory of Illumination, Electives.

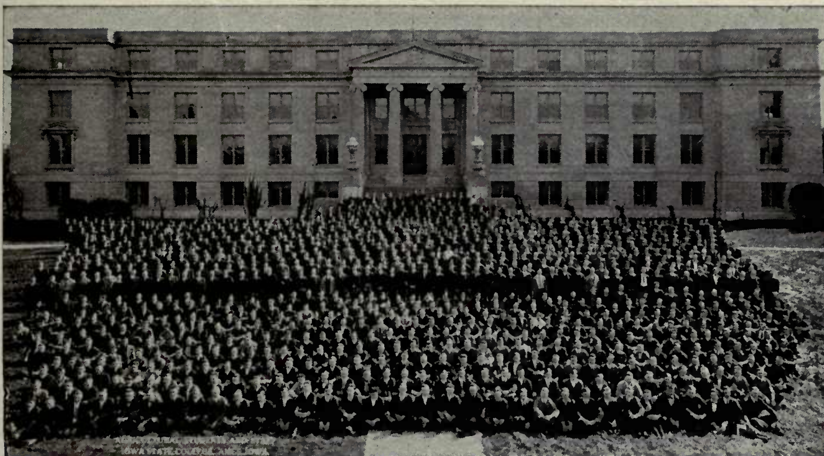
Eighth Semester
Alternating Current Machinery, Laboratory, Electric or Theory of Illumination, Railways or Telephone Engineering, Seminar, Electric Transmission, Thesis, History of Engineering, Electives.

Five-Year Course in Electrical Engineering

Leading to the degree of Bachelor of Science in Electrical Engineering.

The following five-year course in electrical engineering is offered in response to a demand for an engineering course, giving the student a better education in the studies in natural sciences, together with an opportunity to specialize in engineering not possible in the time available in the four-year course of study. The course includes all of the work given in the four-year course and in addition thirty hours of cultural and scientific studies, together with four hours of work given in the engineering departments.

This course leads to the same degree granted to graduates of the four-year course, but a graduate may obtain the full professional degree of electrical engineer after one year of responsible professional work in the presentation of a satisfactory thesis.



FACULTY AND STUDENTS—DIVISION OF AGRICULTURE. HALL OF AGRICULTURE IN THE BACKGROUND.

COURSE IN FARM CROPS AND SOILS

Leading to the degree of Bachelor of Science in Farm Crops and Soils.

FRESHMAN YEAR

First Semester
Shop Work, Market Types of Cattle and Sheep, General Chemistry, Corn Growing and Judging, Farm Dairying, General Horticulture, Library Instruction, Algebra and Trigonometry, Military Drill, Gymnasium Work.

Second Semester
Market Types of Dairy Cattle, Horses and Swine; Shop Work, General Chemistry and Qualitative Analysis, Farm Forestry, Small Grains, Graphic Methods, Plant Morphology, Mechanics, Heat and Light; Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Corn and Small Grain Judging, Agricultural Surveying, Breed Types of Cattle and Sheep, Agricultural Geology, Organic Chemistry, Narration and Description, Military and Physical Training.

Fourth Semester
Forage Crop Production, Farm Machinery and Farm Motors; Breed Types of Dairy Cattle, Horses and Swine; Soil Physics, Agricultural Analysis, Exposition, Military and Physical Training.

JUNIOR YEAR

Fifth Semester
Soil Fertility, Plant Embryogeny, Agricultural Economics, Plant Breeding, General Zoology, General Bacteriology, Seminar.

Sixth Semester
Forage Crop Breeding, Corn and Small Grain Breeding, Farm Crops or Soils, Seminar, Soil Bacteriology, Vegetable Physiology, Farm Management, General or Agronomic Entomology, Electives.

SENIOR YEAR

Seventh Semester
Soil Management, Farm Crops or Soils, Special Problems, Advanced Soil Fertility, Soil Bacteriology, Technical Journalism, Seminar, Electives, Vegetable Pathology, Truck Farming.

Eighth Semester
Advanced Special Problems, Soils or Farm Crops, Seminar, Farm Crops or Soils, Thesis; Animal Feeding, Economic History, American Agriculture, Argumentation or Literature, Electives.

COURSE IN FARM MANAGEMENT

Leading to the degree of Bachelor of Science in Farm Management.

FRESHMAN YEAR

First Semester

Shop Work, Market Types of Cattle and Sheep, General Chemistry, Corn Production, Farm Dairying, General Horticulture, Library Instruction, Algebra and Trigonometry, Military Drill, Gymnasium Work.

Second Semester

Shop Work, Market Types of Dairy Cattle, Horses and Swine; General Chemistry and Qualitative Analysis, Farm Forestry, Small Grains, Graphic Methods, Plant Morphology, Mechanics, Heat and Light; Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester

Agricultural Surveying, Breed Studies, Organic Chemistry, Narration and Description, Corn and Small Grain Judging, Agricultural Geology, Military Drill and Physical Training.

Fourth Semester

Farm Machinery and Farm Motors, Breed Studies, Agricltural Analysis, Exposition, Forage Crop Production, Military Drill and Physical Training, Soil Physics.

JUNIOR YEAR

Fifth Semester

Farm Accounts, Seminar, General Poultry Husbandry, Agricultural Economics, Economic History of American Agriculture, Soil Fertility, General Zoology, Electives.

Sixth Semester

Farm Management, Seminar, Animal Feeding, General Poultry Husbandry, General Bacteriology, Vegetable Physiology, Electives.

SENIOR YEAR

Seventh Semester

Advanced Farm Management, Research, Seminar, Rural Sanitary Equipment or Landscape Gardening, Technical Journalism, Principles of Breeding, Plant Genetics, Truck Farming or Commercial Orcharding, Electives.

Eighth Semester

Thesis, Seminar, Farm Structures, Agricultural Publicity, Corn Breeding, Small Grain Breeding, Forage Crop Breeding, Soil Bacteriology, Electives.

COURSE IN FORESTRY

Leading to the degree of Bachelor of Science in Forestry.

FRESHMAN YEAR

First Semester

General Forestry, Forestry Literature, General Botany, General Chemistry, Narration and Description, Library Instruction, College Algebra, Military Drill, Physical Training.

Second Semester

General Forestry, Plant Physiology, General Chemistry and Qualitative Analysis, Exposition, Industrial History of the United States, Plane Trigonometry, Military Drill, Physical Training.

SOPHOMORE YEAR

Third Semester

Silviculture, Lumbering, Forest Products, Ecology, Applied Organic Chemistry, Mechanical Drawing, General Physics, Military Drill and Physical Training.

Fourth Semester

Forest Mensuration, Forest Planting, Wood Technology, Dendrology, Surveying, Military Drill and Physical Training, General Physics.

Summer Camp

This course occupies twelve weeks during the summer between the Sophomore and Junior years.

JUNIOR YEAR

Fifth Semester

Forest Protection, Forest Administration, Forestry Seminar, History of Forestry, Forest Mapping, Surveying, Forest Economics, Physics of Forest Soils, General Entomology.

Sixth Semester

Forestry Seminar, Timber Preservation, Grading Lumber, Systematic Phanerogams, Range and Poisonous Plants, Chemistry of Forest Products, Surveying, Forest Entomology, Electives.

FOREST MANAGEMENT GROUP

SENIOR YEAR

Seventh Semester

Forest Management, Forestry Seminar, Technical Journalism, Forest Pathology, Agricultural Geology, Landscape Gardening, Extempore Speech, Forest Physiography and Soil Surveying.

Eighth Semester

Forest Valuation, Forestry Seminar, State and National Forest Law, General Bacteriology for Foresters, Timber Testing, Business Law, Shade and Street Tree Management, Electives.

LUMBER MARKETING GROUP

Seventh Semester

Seminar, Commercial Woods, Lumber Markets, Lumber Transportation, Technical Journalism, Accounting, Psychology of Business, Extempore Speech, Electives.

Eighth Semester

Forestry Seminar, Wood Structure, Agricultural Advertising, Timber Testing, Business Law, Accounting, Electives.

Additional Landscape Gardening Year for Forestry Students

Graduates in the above outlined course in Forestry who have credits in Landscape Gardening, Plant Materials, Landscape Design, History of Landscape Gardening, Planting Plans, Horticultural Practice will be recommended for the degree of Bachelor of Science in Horticulture on the completion of the additional year's work listed below.

Ninth Semester

Greenhouse Management, Landscape Practice, Civic Design, Applied Civic Design, Rural Sanitary Equipment, Plant Pathology of Horticultural Plants, Roads and Pavements, Elements of Architecture.

Tenth Semester

Applied Civic Design, Maintenance and Construction, Greenhouse Management, Planting Plans, Surveying, Design, and Theory of Architecture, Freehand Drawing, Electives.

Five-Year Course in Forestry

The degree Bachelor of Science in Forestry is given after the completion of four years' work, and the degree Master of Science in Forestry after the fifth year. For plan of the course of study, see general catalog.

Forestry students are required to complete three months of practical forestry work before graduation, in addition to the summer camp.

COURSE IN HOME ECONOMICS

Leading to the degree of Bachelor of Science in Home Economics.

FRESHMAN YEAR

First Semester

Textiles and Clothing, Personal Hygiene, Plant Morphology, General Chemistry, Exposition, Library Instruction, Language or Mathematics, Physical Culture.

Second Semester

Textiles and Clothing Applied Design, Economic Botany, Qualitative Chemistry, Narration and Description, Language or Mathematics, Physical Culture, Drawing, West in American History.

SOPHOMORE YEAR

Third Semester

Food Selection and Preparation, Applied Art, Organic Chemistry, Physical Culture, General Physics, General Psychology.

Fourth Semester

Food Selection and Preparation, Vocational Guidance and Plant Physiology, Elementary Textile Chemistry, Food Chemistry, Physical Culture, Literature of Modern Life, General Zoology, Electives.

FACULTY AND STUDENTS—DIVISION OF HOME ECONOMICS. HOME ECONOMICS BUILDING IN THE BACKGROUND.

Domestic Science Group

JUNIOR YEAR

Fifth Semester

Textiles and Clothing Advanced Cookery, The House, Physiological Chemistry, Social Economics, Human Physiology.

Sixth Semester

Textiles and Clothing or Advanced Dressmaking, Foods, Marketing, Preparation and Serving Meals, The House, Bacteriology and Fermentations, Human Physiology, Public Speaking, Electives.

SENIOR YEAR

Seventh Semester

Practice Teaching or Public Demonstrations, Theory, History of Art Sculpture, Nutrition and Dietetics, Household Management, Practice House, Household Accounting, Agricultural Journalism or English, Argumentation or Composition, History of Architecture, Electives.

Eighth Semester

Practice Teaching Home Economics, Rural Sociology, History of Art, Painting, Nutrition and Dietetics, Home Nursing, Principles of Applied Sociology, English Classics, Electives.

Domestic Art Group

JUNIOR YEAR

Fifth Semester

Advanced Textiles and Clothing, The House, Cookery, Textile Chemistry, Social Economics, Human Physiology.

Sixth Semester

Advanced Textiles and Clothing or Dressmaking, Textiles, Marketing, Preparation and Serving of Meals; Textile Design, The House, Bacteriology and Fermentations, Human Physiology.

SENIOR YEAR

Seventh Semester

Theory, Public Education and Demonstrations, History of Art, Sculpture; Costume Design, Millinery, Household Management, Household Accounting, Argumentation, Public Speaking, Applied Sociology, History of Architecture, Electives.

Eighth Semester

Practice Teaching Home Economics or Rural Sociology, Public Education and Demonstrations, History of Art, Painting, Costume Design, Millinery, Home Nursing, Principles of Applied Sociology, Household Accounting, Technical Journalism or English, Electives.

COURSE IN HOME ECONOMICS AND AGRICULTURE

A degree is awarded on the completion of the required work of this course.

FRESHMAN YEAR

First Semester

Types and Classes of Beef Cattle and Sheep, Plant Morphology, General Chemistry, Exposition, Corn Production, Textiles and Clothing, Personal Hygiene, Library, Physical Culture.

Second Semester

Shop Work, Market Types of Dairy Cattle, Horses and Swine; General Chemistry and Qualitative Analysis, Narration and Description, Textiles and Clothing, Applied Design, Physical Culture.

SOPHOMORE YEAR

Third Semester

Poultry Husbandry, Organic Chemistry, Farm Dairying, Selection and Preparation of Foods, Applied Design, General Horticulture, Physical Culture.

Fourth Semester

Poultry Husbandry, Food Chemistry, Textile Chemistry, Literature, Farm Management, Food Selection and Preparation, Landscape Gardening, Physical Culture, General Zoology.

JUNIOR YEAR.

Fifth Semester

Botany of Weeds, Social Economics, Advanced Textiles and Clothing, Cookery, Human Physiology, Electives.

Sixth Semester

Bacteriology and Fermentations, Textiles and Clothing, Foods, Marketing, Preparation and Serving Meals, Soils Fertility, Electives.

SENIOR YEAR

Seventh Semester

Household Management, Nutrition and Dietetics, Soil Management, Electives.

Eighth Semester

Farm Machinery and Motors, Rural Sociology, Demonstrations, Home Nursing, Electives.

COURSE IN HORTICULTURE

Leading to the degree of Bachelor of Science in Horticulture.

Pomology

FRESHMAN YEAR

First Semester

Shop Work, Market Types of Cattle and Sheep, General Chemistry, Corn Production, Farm Dairying, General Horticulture, Library Instruction, Algebra and Trigonometry, Military Drill, Gymnasium Work.

Second Semester

Shop Work, Market Types of Dairy Cattle, Horses and Swine; General Chemistry and Qualitative Analysis, Small Grain Production, Graphic Methods, Plant Morphology, Farm Forestry, General Physics, Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester

Commercial Orcharding, General Bacteriology, Vegetable Physiology, Plant Pathology of Horticultural Plants, Farm Accounts, Economic History of American Agriculture, Applied Organic Chemistry, Narration and Description, Military Drill, Physical Training.

Fourth Semester

Horticultural Practice, Plant Propagation, Agricultural Economics, Systematic Spermatophytes, Agricultural Surveying, Mechanics and Machinery, Exposition and Public Speaking, Military Drill and Physical Training.

JUNIOR YEAR

Fifth Semester

Plant Breeding, Fruit and Vegetable Judging, Landscape Gardening or Public Speaking or Methods of Teaching, Orchard Practice, Systematic Pomology, Plant Embryogeny, Soil Physics, General Entomology.

Sixth Semester

Pomology Practice, Principles of Education or Technical Journalism, Soil Fertility, Extempore Speech, Horticultural Entomology, Soil Bacteriology, General Bacteriology, Electives.

SENIOR YEAR

Seventh Semester

Markets and Marketing, Seminar, Fruit Farm Management, Truck Farming, Plant Materials, Special Problems, Thesis, Agricultural Advertising, Technical Journalism, Practice, Soil Surveying and Mapping, Argumentation, Literature of Farm and Country Life, Marketing Agricultural Products, Electives.

Eighth Semester

History and Literature of American Horticulture, Seminar, Grapes and Small Fruits, Advanced Pomology, Selection of Varieties, Thesis, Electives.

Floriculture and Greenhouse Management

For Freshman and Sophomore year see Pomology course.

JUNIOR YEAR

Fifth Semester

Plant Breeding, Greenhouse Construction, Greenhouse Management, Plant Materials Extempore Speech, Truck Farming, Landscape Gardening, Methods of Teaching, Soil Physics, Plant Embryogeny, General Entomology.

Sixth Semester

Floriculture Practice, Garden Flowers, Greenhouse Management, Landscape Design, Principles of Education or Technical Journalism, General Bacteriology, Soil Fertility, Horticultural Entomology.

SENIOR YEAR

Seventh Semester

Seminar, Fruit and Vegetable Judging, Handling Truck Crops, Judging Florists' Exhibits, Floriculture Practice, Commercial Floriculture, Special Problems, Thesis, Greenhouse Pests, Landscape Design, Agricultural Advertising, Technical Journalism Practice, Argumentation, Literature of Farm and Community Life, Soil Surveying and Mapping or Soil Bacteriology, Electives.

Eighth Semester

Seminar, Commercial Floriculture, Thesis, Market Gardening, Truck Farm Management or Landscape Design, History of American Horticulture, Soil Bacteriology, Electives.

Truck Crops and Market Gardening

For Freshman and Sophomore year see Pomology course.

JUNIOR YEAR

Fifth Semester

Plant Breeding, Greenhouse Management, Truck Farming, Orchard Practice, Landscape Gardening, Methods of Teaching, Soil Physics, Plant Embryogeny, Marketing Agricultural Products, General Entomology, Electives.

Sixth Semester

Grapes and Small Fruit, Truck Crops Practice, Greenhouse Management, Principles of Education, Technical Journalism, Soil Fertility, General Bacteriology, Extempore Speech, Horticultural Entomology.

SENIOR YEAR

Seventh Semester

Markets and Marketing, Seminar, Greenhouse Construction, Handling Truck Crops, Fruit and Vegetable Judging, Commercial Floriculture or Canning, Special Problems, Thesis, Greenhouse Pests, Agricultural Advertising, Technical Journalism Practice, Soil Bacteriology, Soil Surveying or Mapping, Argumentation, Literature of Farm and Community Life, Electives.

Eighth Semester

Seminar, Thesis, Market Gardening, Truck Farm Management, Soil Bacteriology, Electives.

Landscape Gardening

For Freshman year, see Pomology or Forestry course.

SOPHOMORE YEAR

Third Semester

General Horticulture, Narration and Description, Landscape Gardening, Applied Organic Chemistry, Surveying, Military Drill, General Physics, Vegetable Physiology, Physical Training, Public Speaking Fundamentals, Elements of Architecture.

Fourth Semester

Plant Propagation, Plant Materials, Landscape Design, Systematic Spermatophytes, Surveying, Mechanical Drawing, Principles of Education, Exposition, Extempore Speech, Military Drill, Physical Training, Freehand Drawing.

JUNIOR YEAR

Fifth Semester

Plant Materials, History of Landscape Gardening, Landscape Design, Plant Pathology, Soil Physics, History of Architecture, General Entomology.

Sixth Semester

Horticulture Practice, Shade and Street Tree Management, Landscape Design, Planting Plans, Design, History and Theory of Architecture, Soil Fertility, Electives.

SENIOR YEAR

Seventh Semester

Greenhouse Management, City Planning, Landscape Practic, Civic Design, Rural Sanitary Equipment, Technical Journalism, Roads and Pavements, Agricultural Geology, Freehand Drawing.

Eighth Semester

Greenhouse Management, Planting Plans, Civic Design, Maintenance and Construction, Thesis, Municipal Forestry, Technical Journalism, Freehand Drawing, Electives.

Additional Forestry Year for Landscape Students

Graduates in the above outlined course in Landscape Gardening, who have credits in Forestry Seminar, General Forestry, Forest Mensuration, Silviculture, Lumbering, Forest Products and Dendrology will be recommended for the degree of Bachelor of Science in Forestry on the completion of Applied Lumbering, Camp Technique, Applied Forest Mensuration and Field Silviculture (Summer Camp), and the additional year's work listed below.

Ninth Semester

Forest Management, Forest Protection, Forest Administration, Seminar, History of Forestry, Ecology, Forest Pathology, Forest Economics, Soil Surveying, Journalism Practice, Argumentation, Extempore Speech.

Tenth Semester

Forest Valuation, Seminar, Timber Preservation, State and National Forest Laws, Municipal Forestry, Forest Planting, Wood Technology, Range and Poisonous Plants, Chemistry of Forest Products, Timber Testing.

FACULTY AND STUDENTS—DIVISION OF INDUSTRIAL SCIENCE.

COURSE IN INDUSTRIAL SCIENCE

Leading to the degree of Bachelor of Science (in some major science).

FRESHMAN YEAR

First Semester

Botany, Chemistry or Zoology; Exposition or Narration and Description, College Algebra, Plane Trigonometry, German, Personal Sanitation and Hygiene (for women) Military Drill (for men), Physical Training (for men), Physical Culture (for women), Library Instruction, Electives for men, three hours; Electives for women, two hours.

Second Semester

Botany, Chemistry or Zoology, Narration and Description or Exposition, Industrial History or Economic History of American Agriculture, Trigonometry, Analytical Geometry, German, Military Drill (for men), Physical Training (for men), Physical Culture (for women), Electives for men, one hour; Electives for women, one hour.

SOPHOMORE YEAR

Third Semester

Science electives, eight hours; German, Military and Physical Training or Physical Culture, Electives, six hours.

Fourth Semester

Science Electives, eight hours; Argumentation or Advanced Composition, German, Military and Physical Training or Physical Culture, Electives, four hours.

JUNIOR AND SENIOR YEARS

Before classification the student must choose a major science subject, and outline his complete course of study for the Junior and Senior years.

A major subject shall be chosen in one of the following departments: Bacteriology and Hygiene. Botany, Chemistry, Economics, Entomology, Geology, Mathematics, Military Science and Tactics, Physics, Veterinary Anatomy, Veterinary Pathology, Veterinary Physiology and Zoology. For details concerning the departmental requirements for major work the student should consult catalog statements of the department chosen. See general catalog for complete plan of course of study.

Applied Chemistry

For Freshman year, see Course in Industrial Science, page 33, which is the same course, except that the student is to elect during the Freshman year, Chemistry to the extent of ten credits.

SOPHOMORE YEAR

Third Semester
Quantitative Analysis, Calculus, General Physics, Military and Physical Training or Physical Culture, Advanced Inorganic Chemistry.

Fourth Semester
Quantitative Analysis, Inorganic Chemistry, Calculus, General Physics, Military and Physical Training or Physical Culture.

JUNIOR YEAR

Fifth Semester
Applied Organic Chemistry, Mineralogy, Mechanical Drawing, Argumentation or Advanced Composition, Extempore Speech, Seminar, German, Electives.

Sixth Semester
Applied Organic Chemistry, General Bacteriology, Projective Drawing, German, Extempore Speech, Seminar, Electives.

SENIOR YEAR

Seventh Semester
Applied Physical Chemistry, Qualitative and Quantitative Analysis of Carbon Compounds, Food Analysis, Seminar, Electives.

Eighth Semester
History of Chemistry, Electrochemistry, Industrial Inorganic Chemistry, Sanitary Chemistry, Seminar, Electives.

Applied Entomology

For Freshman year, see Course in Industrial Science, page 33, which is the same course, except that the student is to elect during the Freshman year, Zoology 2, 3—ten credits.

SOPHOMORE YEAR

Third Semester
General Chemistry, General Botany, General Entomology, General Zoology, Corn Production, German, Military and Physical Training or Physical Culture.

Fourth Semester
Economic Entomology, General Botany, General Zoology, General and Qualitative Chemistry, General Physics, German, Military and Physical Training or Physical Culture.

JUNIOR YEAR

Fifth Semester
Histology, Plant Pathology, General Bacteriology, Organic Chemistry, Electives.

Sixth Semester
Bird Study, Evolution, Orchard and Nursery Inspection, Small Grains, General Horticulture, Electives.

SENIOR YEAR

Seventh Semester
Parasites and Disease-Carrying Insects, Research Entomology, Literature of Entomology, Advanced Composition or Argumentation, Electives.

Eighth Semester
Apiculture, Forest Entomology, Research Entomology, Mechanics and Machinery, Electives.

Applied Geology

For Freshman year, see Course in Industrial Science, page 33, which is the same course, except that the student is to elect during the Freshman year, Chemistry, eight credits.

SOPHOMORE YEAR

Third Semester
Physiography, Quantitative Analysis, Drawing, German, General Physics, Military and Physical Training or Physical Culture.

Fourth Semester
General Geology, Projective Drawing, German, General Zoology, General Physics, Military and Physical Training or Physical Culture.

JUNIOR YEAR

Fifth Semester
Mineralogy, General Geology, Drawing, Surveying, Assaying, Electives.

Sixth Semester
Advanced Geology, Invertebrate Paleontology, Mineralogy or Metallurgy, Surveying, Electives.

Six weeks' summer field work in Geology required for graduation.

SENIOR YEAR

Seventh Semester
Economic Geology, Invertebrate Paleontology, Petrography or Metallurgy, Engineering English, Electives.

Eighth Semester
Geology, Thesis or Special Paleontology, Vertebrate Paleontology, Petrography, Electives.

Apiculture

For Freshman year, see Course in Industrial Science, page 33, which is the same course.

SOPHOMORE YEAR

Third Semester
General Apiculture, General Botany, General Zoology, General Chemistry, Argumentation or Advanced Composition, Military Drill and Physical Training, German.

Fourth Semester
General Apiculture, Systematic Botany, Qualitative Analysis, General Zoology, General Physics, Military Drill and Physical Training, Electives.

JUNIOR YEAR

During the Junior year, the following subjects shall be taken: General Entomology, Organic Chemistry, General Bacteriology, Literature of Entomology, Flowerecology and Bees' Diseases and enough electives to total sixteen credits per semester.

SENIOR YEAR

During the Senior year the student will take research courses (including Apiary inspection) to amount to five hours the first semester and seven hours the second. In each semester electives to total sixteen credits shall be taken.

FIVE-YEAR COURSE IN INDUSTRIAL SCIENCE AND AGRICULTURE, OR ENGINEERING, OR HOME ECONOMICS

Students enrolled in the course in Industrial Science who have completed the work of the Junior year and who have credits in certain subjects noted below, may classify as Junior students in any course in Agriculture, Engineering, or Home Economics and graduate from both courses and receive both degrees at the end of two years or upon the completion of seventy-

two hours of additional work, or in special cases upon the completion of such greater or less number of credits as the Committee on Advanced Credits shall recommend.

The following requirements must be met by students taking advantage of the combined five-year courses:

1. Students will be required to complete all the technical subjects required by the technical department in which they classify.
2. All prerequsites for technical subjects must be met.
3. For classification in the divisions and courses given below, the following credits must be presented:

A. **Division of Agriculture:**

(1) For courses in animal husbandry and dairying: Chemistry, sixteen credits; botany, four credits; physics, three credits; zoology, eight credits; and other science credits to make a total of forty credits.

(2) For courses in agronomy, horticulture, forestry and agricultural education: Chemistry, sixteen credits; botany, eight credits; physics, three credits; zoology, four credits, and other science credits to make up a total of forty credits.

B. **Division of Engineering:**

In all courses: Mathematics, twenty credits, of which six must be in calculus; physics, ten credits; chemistry, eight credits, and other science credits to make a total of forty credits.

Four credits in mechanical drawing must be presented, or which two may be in descriptive geometry.

Students electing mining engineering, ceramics or chemical engineering, should offer, if possible, additional credits in chemistry.

Students electing agricultural engineering should offer, if possible, additional credits in agriculture.

C. **Division of Home Economics:**

In all courses: The student must present in chemistry, sixteen credits; botany, six credits; physics, six credits; zoology, eight credits; and other science credits to make a total of forty credits.

Six-Year Course in Industrial Science and Veterinary Medicine.

Leading to the degree of Bachelor of Science and the degree of Doctor of Veterinary Medicine.

The following course is designed to meet the need of those students who wish to secure a thorough foundation in the biological and chemical sciences preliminary to the studying of veterinary medicine. The degree of Bachelor of Science is granted at the end of the fourth year, and the degree of Doctor of Veterinary Medicine upon the completion of the sixth year. The increased time at the disposal of the student gives an opportunity to prepare himself efficiently for investigational work. For plan of courses of study, see general catalog.

FACULTY AND STUDENTS—DIVISION OF ENGINEERING. ENGINEERING HALL IN THE BACKGROUND.

COURSE IN MECHANICAL ENGINEERING

Leading to the degree of Bachelor of Science in Mechanical Engineering.

FRESHMAN YEAR

First Semester
Drawing, Forge, Technical Lectures, General Chemistry, Exposition, College Algebra, Plane Trigonometry, Military Drill, Gymnasium Work.

Second Semester
Drawing, Foundry, Technical Lectures, General Chemistry and Qualitative Analysis, Narration and Description, Plane Trigonometry, Analytical Geometry, Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Mechanical Drawing, Pattern Work, Quantitative Analysis, Argumentation, Calculus, Military and Physical Training, General Physics.

Fourth Semester
Kinematic Drawing, Pattern Work, Mechanics of Engineering, Pipe Fitting, Quantitative Analysis, Calculus, Military and Physical Training, General Physics.

JUNIOR YEAR

Fifth Semester
Mechanics of Engineering, Materials of Construction, Laboratory, Valve Gear Design, Machine Work, Principles of Electrical Engineering, Engineering English, General Physics.

Sixth Semester
Machine Design, Hydraulics, Mechanical Laboratory, Machine Work, Seminar, Thermodynamics, Direct Current Machinery, Conservation of Natural Resources, Physical Laboratory.

SENIOR YEAR

Seventh Semester
Heating and Ventilation, Steam Engine Turbines, Heating Design, Gas Engines and Producers, Gasoline Automobiles, Laboratory, Steam and Gas Laboratory, Designing, Machine Work, Seminar, Engineering Economics, Alternating Current Machinery, Laboratory, Specifications and Contracts, Thesis.

Eighth Semester
Railway Engineering, Power Plant Engineering, Crane or Gas Engine Design, Seminar, Thesis, Steam and Gas Laboratory, History of Engineering, Elementary Accounting, Automobile Motor Design, Automobile Chassis, Automobile Testing, Electives.

Five-Year Course in Mechanical Engineering

Leading to the degree of Bachelor of Science in Mechanical Engineering.

The five-year course in mechanical engineering is offered in response to a demand for an engineering course giving the student a better education in cultural studies and natural sciences together with an opportunity to specialize in engineering not possible in the time available in the four-year course of study. The course includes all of the work given in the four-year course and in addition, twenty-four hours of cultural and scientific studies, together with ten hours of work taken from the other engineering departments.

COURSE IN MINING ENGINEERING

Leading to the degree of Bachelor of Science in Mining Enginering.

FRESHMAN YEAR

First Semester
Technical Lecture, General Chemistry, Surveying, Exposition, College Algebra, Plane Trigonometry, Mechanical Drawing, Military Drill, Gymnasium Work.

Second Semester
Technical Lecture, General Chemistry, Qualitative Analysis, Surveying, Narration and Description, Plane Trigonometry, Analytical Geometry, Projective Drawing, Military Drill, Gymnasium Work.

Mining Engineering—Field work, two weeks.

SOPHOMORE YEAR

Third Semester
Mine Surveying, Journal Club, Quantitative Analysis, Mechanical Drawing, Calculus, Military and Physical Training, General Physics.

Fourth Semester
Journal Club, Argumentation, General Geology, Mechanics of Engineering, Calculus, Military and Physical Training, General Physics.

Mining Engineering—Summer field work, two weeks.

JUNIOR YEAR

Fifth Semester
Principles of Mining, Assaying, Seminar, Engineering English, Mineralogy, Mechanics of Engineering, Mechanical Laboratory.

Sixth Semetser
Principles of Mining, Metallurgy, Seminar, Structural Engineering, Conservation of Natural Resources, Advanced Geology, Hydraulics.

Mining Engineering—Summer field work, four weeks.

SENIOR YEAR

Seventh Semester
Metallurgy, Principles of Mining, Seminar, Specifications and Contracts, Economic Geology, Steam Engines and Boilers, Electives.

Eighth Semester
Seminar, Mining Engineering, Metallurgy or Geology, Mine Administration and Mining Law, Electrical Machinery, History of Engineering, Power Plant Engineering, Structural Engineering, Electives.

Five-Year Course in Mining Engineering

Leading to the degree of Bachelor of Science in Mining Enginering.

The five-year course in mining engineering is offered in response to a demand for an engineering course giving the student a better education in cultural studies and natural sciences together with an opportunity to spe-

cialize in engineering not possible in the time available in the four-year course of study. The course includes all of the work given in the four-year course and in addition affords opportunity to do more work in cultural and scientific studies during the first three years and to elect additional subjects given in the engineering departments during the last two years.

This course leads to the same degree granted to graduates of the four-year course. A graduate of the five-year course may obtain the full professional degree of Engineer of Mines after one year of responsible professional work and the presentation of a satisfactory thesis.

COURSE IN RURAL STRUCTURE DESIGN

Leading to a two-year Collegiate Certificate in Rural Structure Design.

FRESHMAN YEAR

First Semester
Technical Lecture, Freehand Drawing, General Chemistry, Lettering, Exposition, College Algebra, Plane Trigonometry, Military and Physical Training.

Second Semester
Technical Lecture, Working Drawing, Freehand Drawing, Descriptive Geometry, Surveying, Narration and Description, Plane Trigonometry, Military and Physical Training.

SOPHOMORE YEAR

Third Semester
Rural Design, Specifications and Estimating, Freehand Drawing, Argumentation, Calculus, Military and Physical Training.

Fourth Semester
Rural Design, Sanitation of Buildings, Freehand Drawing, Farm Structures, Landscape Gardening, Calculus, Mechanics of Engineering, Military and Physical Training.

COURSE IN VETERINARY MEDICINE

Leading to the degree of Doctor of Veterinary Medicine.

FRESHMAN YEAR

First Semester
Osteology and Arthrology, Microscopy and Microscopic Anatomy, Market and Breed Types, Structural Botany, General Chemistry, Military Drill, Gymnasium Work.

Second Semester
Myology and Splanchnology, Microscopic Anatomy of the Organs, Market and Breed Types, English, Library Instruction, Bio-Chemistry, Military Drill, Gymnasium Work.

SOPHOMORE YEAR

Third Semester
Anatomy, General and Pathogenic Bacteriology, Comparative Physiology, Military and Physical Training, General Zoology.

Fourth Semester
Comparative Anatomy, Embryology, General Pathology, Comparative Physiology, Military and Physical Training.

JUNIOR YEAR.

Fifth Semester

Special Pathology, Pharmacy, Practice and Diagnosis, Clinics, Materia Medica, Animal Feeding.

Sixth Semester

Animal Parasites, Therapeutics, Practice and Diagnosis, Clinics, General Surgery and Surgical Technique.

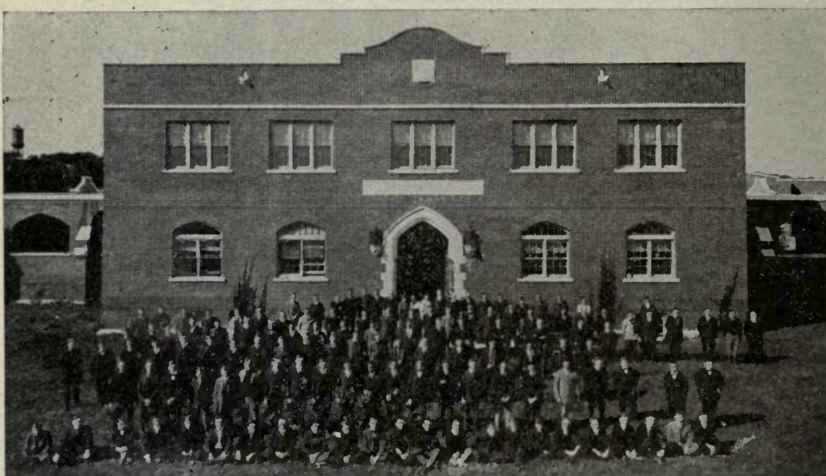
SENIOR YEAR

Seventh Semester

Meat Inspection, Advanced Pathology, Obstretrics, Special Surgery, Clinics, Infectious Diseases and Sanitation.

Eighth Semester

Special Surgery, Immunity and Serum Therapy, Infectious Diseases and Sanitation, Clinics, Milk Hygiene, Veterinary Law.



FACULTY AND STUDENTS—DIVISION OF VETERINARY MEDICINE. VETERINARY ADMINISTRATION BUILDING IN THE BACKGROUND.

NON-COLLEGIATE COURSES

REQUIREMENTS FOR ADMISSION

Any student desiring to enter a non-collegiate course must be at least seventeen years of age (except for the two-year course in home economics where the student must be eighteen years of age), and must present a certificate signed by his county or high school superintendent showing that he has satisfactorily completed the eighth grade of the public schools or its equivalent. If the applicant has attended high school, this certificate must also give his complete high school or academic record. All applications for admission should be addressed to the Registrar, Iowa State College, who will furnish the proper blanks. These certificates should be filed with the Registrar as promptly as possible, and at least two weeks before the opening of the semester.

These courses are not intended to be preparatory for the four-year courses, though through them some entrance credit may be secured. This is, however, not their chief function, and students who are merely seeking entrance credits are advised to obtain them in the high school.

High school graduates who are able to meet the entrance requirements of the collegiate courses, or students who are able to present 14 units of acceptable high school or academic work, are not eligible to the non-collegiate courses, with the exception of the one-year dairy course. Such students are referred to the two-year collegiate course in agriculture as set forth on page 20. Opportunities are there offered for work of advanced grade covering practically the same subjects as are taught in the non-collegiate courses. This work is better adapted to high school graduates than is that of the two-year non-collegiate courses.

TWO-YEAR COURSE IN AGRICULTURE

(Requirements for Admission, see page 41)

Upon the completion of this course, the student will be granted a certificate.

FIRST YEAR

First Semester

Blacksmithing or Carpentry, Market Types, Feeding and Management, Farm Weeds and Seeds, Agricultural Chemistry, Principles of Dairying, English, Corn Production, Agricultural Botany, Gymnasium Work, Military Drill, Elective.

Second Semester

Blacksmithing or Carpentry, Agricultural Surveying, Fruit Growing, Market Types, Feeding and Management, Small Grains, English, Farm Accounts, Gymnasium Work, Plant Propagation, Military Drill, Elective.

Practical Agriculture—three months' work.

SECOND YEAR

Third Semester

Farm Machinery and Motors, Breed Types of Cattle and Sheep, Farm Management, Gymnasium Work, Soil Physics, Electives.

Fourth Semester

Agricultural Electives, Farm Buildings, Grasses and Forage Crops, Rural Economics, Gymnasium Work, Soil Fertility, Breed Studies.

ONE-YEAR COURSE IN DAIRYING

(Requirements for Admission, see page 41)

Upon the completion of this course and one year of practical experience, the student will be granted a certificate.

FIRST YEAR

First Semester

Dairy Practice, Buttermaking, Milk Testing, Bacteriology, Dairy Engineering, Breeding and Judging Dairy Cattle, Dairy Chemistry, Soils and Fertilizing Materials, Gymnasium Work.

Second Semester

Dairy Practice, Buttermaking, Milk Testing, Judging Dairy Products, Cheesemaking, Factory Management, Market Milk, Feeding and Management of Dairy Cattle, Preparation of Ice Cream and Ices, Judging Dairy Stock, General Farm Crops, Gymnasium Work.

TWO-YEAR COURSE IN HOME ECONOMICS

(Requirements for Admission, see page 41)

Upon the completion of this course, the student will be granted a certificate.

FIRST YEAR

First Semester

Food Study and Preparation, Garment Making and Handwork, Textiles, Personal Hygiene, Elementary Chemistry, English, Physical Culture, Electives.

Second Semester

Food Study and Preparation, Dressmaking, Textiles, Applied Design, Chemistry of Foods, Elementary Composition, Physical Culture, Electives.

SECOND YEAR

Third Semester

Food Study and Preparation, Dressmaking, Costume Design, Art Appreciation, Human Physiology and Home Nursing, Physical Culture, Household Bacteriology, Literature of the Home.

Fourth Semester

General Cookery, Home Decoration, Millinery and Dressmaking, Small Fruits and Vegetables, Child Study, Household Dairying, Household Management, Electives.

TWO-YEAR COURSE IN HOME ECONOMICS AND AGRICULTURE

(Requirements for Admission, see page 41)

Upon the completion of this course, the student will be granted a certificate.

FIRST YEAR

First Semester

Food Study and Preparation, Garment Making and Handiwork, Farm and Business Arithmetic, Practice of English, Elementary Chemistry, Physiology and Personal Hygiene, Agricultural Botany, Physical Culture.

Second Semester

Food Study and Preparation, Dressmaking, Civics and History, Poultry Management, Farm Crops Production, Elementary Horticulture, Elementary Composition, Physical Culture.

SECOND YEAR

Third Semester

Food Study and Preparation, Dressmaking, Literature of the Home, Methods of Teaching, Manual Training, Animal Husbandry, Soils, Farm Weeds and Seeds, Rural Recreation.

Fourth Semester

Trade Dressmaking, Household Management, Methods of Teaching, Home Decoration and Furnishing, Manual Training, Animal Husbandry, Household Dairying, Educational Psychology, Electives.

VOCATIONAL COURSES IN ENGINEERING

Two-Year Course for Electrical Workers and Stationary Engineers

(Requirements for Admission, see page 41)

Upon the completion of this course the student will be granted a certificate.

FIRST YEAR

First Semester

Principles of Chemistry, *English, *Shop Mathematics or Algebra, *Shop Drawing, Shop Work—Wood Work, Foundry, Principles of Physics, Gymnasium Work.

Second Semester

*Elementary Electricity and Magnetism, *English, *Shop Mathematics or Algebra or Plane Geometry, *Shop Drawing, Pattern Work, *Steam Boilers, Gymnasium Work.

SECOND YEAR

Third Semester

Wiring Diagrams, Direct and Alternating Current Machinery, Practical Wiring, *Plane or Solid Geometry, *Shop Sketching, Machine Work, *Gas Engines, Gymnasium Work.

Fourth Semester

Dynamo Practice, Practical Experience, *Plane Trigonometry, Machine Work, Pipe Fitting, Power Plant Operation, Gymnasium Work, *Heating and Sanitation of Buildings.

*May be taken by correspondence.

The department reserves the right to substitute equivalent work in the schedule of any student if the enrollment in any one study is not sufficient to warrant conducting a class in that subject.

Two-Year Course for Mechanical Draftsmen and Mechanicians

(Requirements for Admission, see page 41)

Upon the completion of this course, the student will be granted a certificate.

FIRST YEAR

First Semester

Principles of Chemistry, *English, *Shop Mathematics or Algebra, *Shop Drawing, Wood Work, Foundry, Principles of Physics, Gymnasium Work.

Second Semester

Cement Products, *English, *Algebra or Plane Geometry, *Shop Drawing, Pattern Work, *Steam Boilers, Gymnasium Work.

SECOND YEAR

Third Semester

*Plane or Solid Geometry, *Shop Sketching, *Gas Engines, Drafting Room Practice, Machine Shop, *Strength of Materials, Gymnasium Work.

Fourth Semester

*Trigonometry, Drafting Room Practice, Machine Shop, Pipe Fitting, *Heating and Sanitation of Buildings, *Elements of Mechanics, Gymnasium Work, Practical Experience.

*May be taken by correspondence.

The department reserves the right to substitute equivalent work in the schedule of any student if the enrollment in any one study is not sufficient to warrant conducting a class in that subject.

Two-Year Course for Structural Draftsmen and Building Superintendents

(Requirements for Admission, see page 41)

Upon the completion of this course, the student will be granted a certificate.

FIRST YEAR

First Semester

Principles of Chemistry, *English, *Arithmetic or Algebra, Shop Work, Gymnasium Work, Principles of Physics, Drawing.

Second Semester

Field Engineering, *English, Landscape Gardening, *Algebra or Plane Geometry, Gymnasium Work, Drawing, Freehand Sketching, Building Construction.

SECOND YEAR

Third Semester

*Plane or Solid Geometry, *Strength of Materials, Gymnasium Work, Plan Reading and Estimating, Drawing, Interior Decoration.

Fourth Semester

*Elements of Structure, Cement Products, *Trigonometry, *Heating and Sanitation of Buildings, Gymnasium Work, Drawing, Practical Experience.

*May be taken by correspondence.

The department reserves the right to substitute equivalent work in the schedule of any student if the enrollment in any one study is not sufficient to warrant conducting a class in that subject.

Two-Year Course for Suveyors and Road Makers

(Requirements for Admission, see page 41)

Upon the completion of this course, the student will be granted a certificate.

FIRST YEAR

First Semester

Principles of Chemistry, *English, *Shop Mathematics or Algebra, *Shop Drawing, Shop Work, Gymnasium Work, Principles of Physics.

Second Semester

Cement Products, Drawing, Road Making, Field Engineering, *English, *Algebra or Plane Geometry, Gymnasium Work.

SECOND YEAR

Third Semester

Surveying, Topographical Drawing, Drainage and Irrigation, *Plane or Solid Geometry, *Strength of Materials, Gymnasium Work.

Fourth Semester

Surveying, *Elements of Structures, *Trigonometry, *Elements of Mechanics, Building Construction, Gymnasium Work, Practical Experience.

*May be taken by correspondence.

The department reserves the right to substitute equivalent work in the schedule of any student if the enrollment in any one study is not sufficient to warrant conducting a class in that subject.

Optional Studies in the Non-Collegiate Courses

With the consent of the Dean of Agriculture for agricultural students, of the Dean of Engineering for the engineering students, and of the Dean of Home Economics for the home economics students, students having the prerequisite preparation may elect subjects from the following list, in place of any study named in the regular semester schedules, provided they have the equivalent of two and one-half years of high school work, or have received credit in advance for part of the required work scheduled. Two-year students may take an additional course in English in the second year with the approval of their dean.

Fall Semester

General Botany, Plant Diseases, Small Fruits and Vegetables, Algebra, Shop Mathematics, Algebra to Involution, Shop Drawing, Elementary German, Automobile Operation, Automobile Practice, Principles of Physics, Drawing.

Spring Semester

Cement Products, Greenhouse Crops, Practical Landscape Gardening, Algebra, Plane Trigonometry, Shop Drawing, German, Drawing.

Either Semester

The Sentence, Rhetoric and Composition, Elementary Grammar, The Informational Article, Modern European History, Advanced American History, English Classics, Public Speaking.

English Practice, Algebra Review, Plane Geometry, Solid Geometry, Wood Shop Work, Pattern Work, Forge Work, Foundry Work.

Special Part-Time Course for Telephone Plant-Men

(Requirements for Admission, see page 41)

This course is to be given in co-operation with telephone companies for young men who are (or expect to be) engaged in telephone work. It is open to any young man in the state, but only those detailed by telephone companies are certain of employment when the school work is completed. The course will probably require two years of alternating school work and practical work. The student will devote five months each year (May to September, inclusive) to practical work at regular wages in the employ of the telephone company, and seven months (October to April, inclusive) to school work at the Iowa State College.

First Semester

The Practice of English, Telephony, Telephone Practice, Algebra or Shop Mathematics, Shop Drawing, Wood Shop Work, Elementary Physics, Gymnasium Work.

Second Semester

Elementary Composition, Telephony, Telephone Practice, Algebra or Shop Mathematics, Shop Drawing, Forge Work, Elementary Physics, Gymnasium Work.

DEPARTMENT OF MUSIC AND AFFILIATED SCHOOL OF MUSIC

The aim of the Department of Music is to afford to all students who have any interest in music, a means of developing their musical abilities. It provides for each student an opportunity for active participation by offering a number of studies, some one of which may fit the particular abilities and needs of the individual.

The classes in ths subjects named below recite twice a week, and college credit is given:

Military Band, History of Music, Elementary Harmony, Advanced Harmony. Elementary Chorus, Advanced Chorus, Orchestra.

In addition to the regular classes of the Department of Music, instruction in piano, voice, violin and pipe organ is offered. Also practice pianos are maintained for the use of the students. The rates for private lessons and practice are as follows:

Tuition per College Semester

One half-hour lesson per week	$20.00
Two half-hour lessons per week	35.00
Piano practice 1 hour per day	3.50
Piano practice 2 hours per day	6.50
Piano practice 3 hours per day	9.00
Pipe organ practice 1 hour per day	8.00

MUSICAL ORGANIZATIONS

The Glee Clubs admit members by competitive examination at the beginning of the year. The work is of a very high order, and all students who sing are eligible.

Men's Glee Club—Annual tours are made during college vacations, including the larger towns of Iowa and the adjoining states. The college letter "A" is awarded to members who have to their credit two consecutive years of Glee Club work. At present the club has 42 members, of whom 26 are taken on the tour at Christmas and a large number at Easter.

Women's Glee Club—This organization, numbering 42 members, gives concerts at the college and makes an Easter tour.

SUMMER SESSION

Twelve-Weeks Summer School devoted to both collegiate and non-collegiate courses. Work for regular students, high school teachers, superintendents, rural and grade teachers. Write the Director of Summer School, or the Registrar, for special announcement regarding the courses offered.

GENERAL INFORMATION

The Iowa State College of Agriculture and Mechanic Arts was established in 1858 by an act of the legislature of Iowa. The college domain was purchased in 1859. In 1862 the legislature accepted the federal land grant act approved in that year by President Lincoln. This act includes the requirement that "where the leading object shall be, without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and mechanic arts, in such manner as the legislature of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." The college was formally opened on the seventeenth day of March, 1869.

Acres in College Domain	1,342	Agricultural Equipment	$140,000.00
Acres in Campus	125	Home Economics Equipm't	13,000.00
Trees on Central Campus	2,500	Industrial Science Equipment	110,000.00
Varieties of Trees	120	Engineering Equipment	114,000.00
College Buildings	50	Veterinary Equipment	32,000.00
Volumes in Library	55,000	Botanical Museum	4,500.00
College Property	$3,763,402.08	Departments Maintained	52
Zoological Museum	15,000		

A BIRD'S-EYE VIEW OF THE CAMPUS FROM THE EAST.

ENROLLMENT AT IOWA STATE COLLEGE, 1916-17

Collegiate—

Graduate	114
Agriculture	975
Engineering	746
Home Economics	552
Industrial Science	118
Veterinary Medicine	133
Total	2,638
Less duplicates	77
	2,561

Non-Collegiate—

Two and One-Year Agriculture	213
Two-Year Engineering	61
Two-Year Home Economics	52
Music	99
Total	425
Less duplicates	70
	355

Net Total of Collegiate and Non-Collegiate	2,916

Summer Session—

First Session	738
Second Session	260
Total	998
Less duplicates	405
Net total	593

Net Total of Collegiate, Non-Collegiate and Summer Session	3,509

Winter Short Course—

Agriculture	2,346
Engineering	183
Home Economics	339
Veterinary Practitioners'	201
Total	3,069
Less duplicates (estimate)	200
Net total	2,869

Grand total (Net)	6,378

THE COLLEGE

The Iowa State College of Agriculture and Mechanic Arts conducts work in five major lines:

AGRICULTURE
ENGINEERING
HOME ECONOMICS
INDUSTRIAL SCIENCE
VETERINARY MEDICINE

The Graduate Division conducts advanced research and instruction in all these five lines.

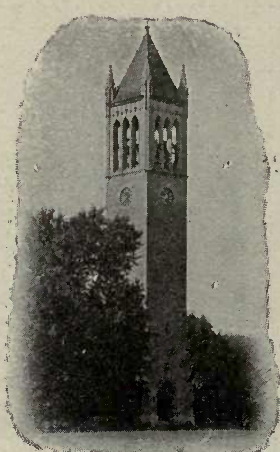
Four-year, five-year and six-year collegiate courses are offered in different divisions of the College. Non-collegiate courses are offered in agriculture, engineering and home economics. Summer sessions include graduate, collegiate and non-collegiate work. Short courses are offered in the winter.

Extension courses are conducted at various points throughout the state.

Research work is conducted in the Agricultural and Engineering Experiment Stations and in the Veterinary Research Laboratory.

Special announcements of the different branches of the work are supplied, free of charge, on application. The general college catalogue will be sent on request. Address,

Herman Knapp, Registrar,
Ames, Iowa.



CAMPANILE

OFFICIAL PUBLICATION OF
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

Vol. XV

APRIL 1, 1917

No. 32

General Catalogue

1917-1918

Ames, Iowa

Pub'ished Tri-Monthly by the Iowa State College of Agriculture and Mechanic Arts. Entered as Second Class Matter at the Post Office at Ames, Iowa. under the Act of Congress of August 24, 1912.

CALENDAR

1917

JANUARY

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APRIL

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OCTOBER

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1918

JANUARY

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MARCH

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APRIL

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JUNE

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Contents

College Calendar
1917-1918

The General College Faculty meets on the third Monday of each month at 4 P. M. in Central Building. The faculties of the different divisions meet during the week of the first Monday of each month, as follows:

Monday, 4 P. M.	Home Economics
Tuesday, 4 P. M.	Veterinary Medicine
Wednesday, 4 P. M.	Engineering
Thursday, 4 P. M.	Agriculture
Friday, 4 P. M.	Industrial Science

FIRST SEMESTER

September 6-7, Thursday and Friday, 8:00 A. M.	Entrance Examinations.
September 10-11, Monday, 8:00 A. M., to Tuesday, 5:00 A. M.	Registration-Classification Days.
September 12, Wednesday, 7:40 A. M.	College Work begins.
September 15, Saturday, 8:00 P. M.	Y. W. C. A. and Y. M. C. A. Reception.
October 6, Saturday, 8:00 P. M.	Junior Trot.
October 13, Saturday, 8:00 P. M.	Agricultural Reception.
October 20, Saturday, 8:00 P. M.	Sophomore-Freshman Annual.
November 28, Wednesday, 8:00 P. M.	Y. W. C. A. Party.
November 29, Thursday	Thanksgiving Vacation.
December 19, Wednesday, 12:00 M.	Christmas Vacation begins.
January 2, Wednesday, 12:00 M.	Vacation closes.
January 25, Friday, 12:00 M.	First Semester closes.

SPECIAL SHORT COURSES AND CONVENTION WEEK

JANUARY 28, MONDAY, TO FEBRUARY 2, SATURDAY

SECOND SEMESTER

January 31-February 1, Thursday and Friday, 8:00 A. M.	Entrance Examinations.
February 4-5, Monday, 8:00 A. M., to Tuesday, 5:00 P. M.	Registration-Classification Days.
February 6, Wednesday, 7:40 A. M.	College Work begins.
February 9, Saturday, 8:00 P. M.	Y.W.C.A. and Y.M.C.A. Reception.
March 9, Saturday, 8:00 P. M.	Freshman-Sophomore Annual.
March 15-16, Friday, 1:00 P. M. to Saturday, 12:00 M.	Engineers' Open House.
March 16, Saturday, 8:00 P. M.	Engineers' Ball.

March 28, Thursday, 12:00 M.	Easter Vacation begins.
April 1, Monday, 5:00 P. M.	Easter Vacation closes.
April 13, Saturday, 8:00 P. M.	Military Ball.
May 17, Friday	Last Day for Presenting Theses to Thesis Committee for the Phi Lambda Upsilon Gold Medal.
May 4, Friday, 3:30 P. M.	May Day Fete.
May 30, Thursday	Decoration Day.
May 31, Friday, 8:00 P. M.	Senior Promenade.
June 1, Saturday, 8:00 P. M.	Semester Musical Recital.
June 2, Sunday, 10:30 A. M.	Baccalaureate Sermon.
June 3, Monday, 2:00 P. M.	Graduation Exercises of Literary Societies.
June 4, Tuesday, 9:30 A. M.	Alumni Business Meeting.
June 4, Tuesday, 8:00 P. M.	Senior Class Play.
June 5, Wednesday, 1:00 P. M.	Alumni, Faculty, Senior Banquet.
June 5, Wednesday, 8:00 P. M.	Senior Class Play.
June 6, Thursday, 10:30 A. M.	Commencement.
June 6, Thursday, 2:30 P. M.	President's Reception.

SUMMER SESSION

June 10, Monday, 7:00 A. M.	Summer School begins.
August 29, Thursday, 12:00 M.	Summer School closes.

FIRST SEMESTER, 1918-1919

September 5-6, Thursday and Friday, 8:00 A. M.	Entrance Examinations.
September 9-10, Monday, 8:00 A. M., to Tuesday, 5:00 P. M.	Registration-Classification Days.

Iowa State Board of Education

D. D. Murphy, President....................................Elkader
W. H. Gemmill, Secretary....................................Des Moines

MEMBERS OF BOARD

TERMS EXPIRE JULY 1, 1917

Geo. T. Baker....................................Davenport
H. M. Eicher....................................Washington
*Willard C. Stuckslager....................................Lisbon

TERMS EXPIRE JULY 1, 1919

P. K. Holbrook....................................Onawa
Chas. R. Brenton....................................Dallas Center
D. D. Murphy....................................Elkader

TERMS EXPIRE JULY 1, 1921

Paul Stillman....................................Jefferson
Edw. P. Schoentgen....................................Council Bluffs
*Frank F. Jones....................................Villisca

STANDING COMMITTEES

Faculty Committee—D. D. Murphy, P. K. Holbrook, H. M. Eicher, Paul E. Stillman, W. C. Stuckslager.

Building and Business Committee—Chas. R. Brenton, D. D. Murphy, Edw. P. Schoentgen, Geo. T. Baker, F. F. Jones.

FINANCE COMMITTEE

W. R. Boyd, Chairman....................................Cedar Rapids
Thos. Lambart....................................Sabula
W. H. Gemmill, Secretary....................................Des Moines

INSPECTORS OF SECONDARY SCHOOLS

**P. E. McClenahan, Inspector....................................Des Moines
John E. Foster, Inspector....................................Des Moines

* Appointed by the Governor since the adjournment of the Thirty-sixth General Assembly.

**Absent on leave.

Officers of Administration

GENERAL OFFICERS

Raymond Allen Pearson, LL. D. . . . . President
Room 104, Central Building.

Edgar Williams Stanton, LL. D. . . . . Vice-President and Secretary
Room 117, Central Building.

Herman Knapp, B. S. A. . . . . Treasurer and Registrar
Room 122, Central Building.

Orange Howard Cessna, D. D. . . . . Chaplain
Room 212, Central Building.

Thomas Sloss. . . . . Superintendent of Buildings and Grounds
Superintendent's Office.

Charles G. Tilden, M. D. . . . . Physician and Sanitary Officer
Hospital Building.

Mrs. Emily Cunningham. . . . . Advisor to Women
Margaret Hall.

Vera Morlan Dixon. . . . . Assistant Librarian
Room 107½, Central Building.

George Platt Bowdish. . . . . Assistant Purchasing Agent
Room 124, Central Building.

Carl Henry Schemann, B. S. in C. E. . . . . Assistant to the President
Room 104, Central Building.

Charles Sabin Nichols, C. E. . . . . . . Assistant to the Dean of Engineering
Room 315, Engineering Hall.

Minnie R. Rice. . . . . Assistant Registrar
Room 122, Central Building.

Clarence E. Brashear, B. S. in Agr. . . Assistant to the Dean of Agriculture
Room 124, Hall of Agriculture.

DEANS AND VICE DEANS

Edgar Williams Stanton, LL. D. . . . . Dean of the Junior College
Room 114, Central Building.

Charles Franklin Curtiss, D. S........Dean of the Division of Agriculture
Room 124, Hall of Agriculture.

Anson Marston, C E.................Dean of the Division of Engineering
Room 315, Engineering Hall.

Charles Henry Stange, D. V. M......Dean of the Division of Veterinary Medicine
Room 107, Veterinary Building.

Robert Earle Buchanan, Ph. D..Dean of the Division of Industrial Science
Room 101, Science Building.

Catherine J. MacKay..........Dean of the Division of Home Economics
Room 106, Home Economics Building.

Spencer Ambrose Beach, M. S...Vice Dean of the Division of Agriculture
Room 201, Hall of Agriculture.

Samuel Walker Beyer, Ph. D.......Vice Dean of Division of Engineering
Room 303, Engineering Hall.

Maria M. Roberts, B. L..................Vice Dean of the Junior College
Room 218, Central Building.

Harold Edwin Bemis, D. V. M............Vice Dean of the Division of Veterinary Medicine
Room 108, Veterinary Building.

AGRICULTURAL EXPERIMENT STATION

Charles Franklin Curtiss, D. S....................................Director
Room 124, Hall of Agriculture.

William Henry Stevenson, B. S. A..........................Vice Director
Room 25, Hall of Agriculture.

ENGINEERING EXPERIMENT STATION

Anson Marston, C. E...Director
Room 315 Engineering Hall.

Charles Sabin Nichols, C. E....................Assistant to the Director
Room 315, Engineering Hall.

FACULTY COMMITTEES

Note: The star denotes that committee has coöperating student members.

Advanced Standings and Substitutions.—Professor Knapp, chairman; Professors Ford, MacDonald, Martin, and department heads concerned.

Appointments.—Professor Wilson, chairman; Professors MacKay, Meeker, Roberts.

Catalogue Editing.—Professor Raymond, chairman; Professors Beach, Bergman, Fish, MacDonald, MacKay; Associate Member, Mr. Weldin.

Course of Study.—Dean Stanton, chairman; Professors Beach, Bemis, Buchanan, Cleghorn, MacKay, Marston, Pew.

Dates of Events.—Professor Harris, chairman; Professors Emily Cunningham, Raymond, Schmidt, Shattuck, Williams; Associate Members, Mr. Hansen, Mr. Schemann.

Efficiency of Equipment.—Professor Knapp, chairman; Professors Munger, Norman.

Entrance Requirements and Secondary School Relations.—Professor Knapp, chairman; Professors Bemis, Fisher, Hodson, Shearer, Snedecor, Wilson.

Fraternities.—Dean Buchanan, chairman; Professors Coover, Fish, Meeker, Pew, Stanton.

Graduate Study.—The President, chairman; Professors Stevenson, Beyer, Chaney, Dimock, MacKay, Pammel.

*Grounds and Buildings.**—The President, chairman; Professors Culley, Curtiss, Marston, Pammel, Stange, Stanton; Associate Members, Messrs. Erwin, T. H. MacDonald, Sloss.

Lectures.—Professor Raymond, chairman; Professors Brown, Bartholomew, Fisher.

Library.—Dean Curtiss, chairman; Professors Brandt, Buchanan, Hodson, Kimball, Lloyd-Jones, Murphey, Raymond; Associate Member, Miss Dixon.

Literary Societies—(Including Forensics).—Professor Schmidt, chairman; Professors Brindley, Noble.

*Moral Welfare.**—Professor Cessna, chairman; Professors Costelloe, Emily Cunningham, Hughes, King, Wilkinson; Associate Member, Mr. Hansen.

*Publicity.**—Professor Beckman, chairman; Professors Colburn, Knapp, Shearer, Turpin; Associate Members, Messrs. Jones, Nichols, Parry.

*Public Health.**—Dr. Tilden, chairman; Professors Bergman, Brown, Evinger, Hammer, Kimball; Associate Member, Mr. Levine.

*Public Safety.**—Professor Meeker, chairman; Professors Coover, Dimock, King, Mortensen; Associate Member, Mr. Wagner.

*Public Service.**—Professor Pew, chairman; Professors Brindley, Morbeck, Murphey, Norman, Wright.

Rules.—Professor Spinney, chairman; Professors Bartholomew, Hammer, Hughes, Lincoln, Murray, Test.

Scholarship.—Dean Stanton, chairman; Professors Gettemy, Hechler, Meeker, Noble, Roberts.

Student Accommodations.—Professor Costelloe, chairman; Professors Lloyd-Jones, Fowler, Guthrie, Stiles; Associate Members, Messrs. Hansen, Schemann.

Student Social Life.—Mrs. Cunningham, chairman; Professors Buchanan, Fish, Roberts, Fisher, Stevenson.

Thesis.—Professor Pammel, chairman; Professors Ford, Major, Stevenson.

Tuition Scholarships.—Professor Briggs, chairman; Professors Ferrin, Crum.

COUNCILS

NOTE: The star denotes that council has coöperating student members.

*Athletic Council.**—The President, chairman; Professor Knapp, treasurer; Professor Williams, secretary; Professors Beyer, Coover, Curtiss; Student Members, John L. Evans '17, Chas. A. Marsh '18, William Davis '19, Merle D. Wilson '20.

*Music Council.**—The President, chairman; Professor Knapp, treasurer; Professor Bemis, secretary; Professors Harris, MacKay, Schmidt; Student Members, V. L. Rushfeldt '17, A. Weed '18.

Summer Session Council.—The President, chairman; Deans of Divisions which give work, and the Director of the Summer Session.

AFFILIATED COMMITTEE

Women's Housing Committee.—Mrs. Stanton, chairman; Mrs. Cunningham, Miss MacKay, Mrs. Marston, Miss Roberts.

Collegiate Work

*Officers of Instruction

President and Deans

Raymond Allen Pearson. 1912 .... President
B. S. in Agr., Cornell University, 1894; M. S. in Agr., 1899; LL. D., Alfred University, 1909; D. of Agr., University of Nebraska, 1917.

Edgar Williams Stanton. **1877, 1873 ...... Vice-President, Dean of the Junior College, Professor of Mathematics
B. Sc., Iowa State College, 1872; M. Sc., 1887; LL. D., Coe College, 1904.

Charles Franklin Curtiss. 1897, 1891 .... Dean of the Division of Agriculture, Director of Experiment Station
B. S. A., Iowa State College, 1887; M. S. A., 1892; D. S. in Agriculture, Michigan Agricultural College, 1907.

Anson Marston. 1892 .... Dean of the Division of Engineering, Professor of Civil Engineering
C. E., Cornell University, 1889.

Charles Henry Stange. 1909, 1907 ..... Dean of the Division of Veterinary Medicine, Professor of Veterinary Theory and Practice
D. V. M., Iowa State College, 1907.

Robert Earle Buchanan. 1909, 1904 ..... Dean of the Division of Industrial Science, Professor of Bacteriology
B. S., Iowa State College, 1904; M. S., 1906; Ph. D., University of Chicago, 1908.

Catharine J. MacKay. 1911, 1910 .... Dean of the Division of Home Economics, Professor of Home Economics
Diploma, Drexel Institute, 1907; Boston Cooking School, 1907; Teachers' College, Columbia University, 1910, 1914.

Professors

T. R. Agg. 1915, 1913 .... Professor of Highway Engineering
B. S. in E. E., Iowa State College, 1905; C. E., 1914.

Spencer Ambrose Beach. 1905 .... Vice Dean of the Division of Agriculture, Professor of Horticulture
B. S. A., Iowa State College, 1887; M. S., 1892.

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* The collegiate faculty consists of the President, Deans, Registrar, all Professors and Associate Professors doing collegiate work, Librarian, Advisor to Women, Director of Agricultural Extension Work, and Director of Engineering Extension Work.

** First date after the name indicates date of appointment to professional position; the second date, when the first fails to do so, indicates the date of first appointment in the College.

Frederick William Beckman. 1911..Professor of Agricultural Journalism
Ph. B., University of Iowa, 1897.

Harold Edward Bemis. 1913, 1908........Vice Dean of the Division of Veterinary Medicine, Professor of Veterinary Surgery
D. V. M., Iowa State College, 1908.

*Alfred Allen Bennett. 1885....................Professor of Chemistry
B. Sc., University of Michigan, 1877; M. Sc., Iowa State College, 1888.

Henry Dale Bergman. 1916, 1910..........Professor of Physiology and Pharmacology
D. V. M., Iowa State College, 1910.

Samuel Walker Beyer. 1898, 1891—Vice Dean of the Division of Engineering, Professor of Geology and Mining Engineering
B. S., Iowa State College, 1889; Ph. D., Johns Hopkins Univ., 1895.

Ralph Kenneth Bliss. 1914..........Director of Agricultural Extension
B. S. A., Iowa State College, 1905.

Fletcher Briggs. 1909..................Professor of Modern Languages
Ph B.., University of Iowa, 1901; M. A., 1902.

John Edwin Brindley. 1913, 1907..............Professor of Economics
B. L., University of Wisconsin, 1902; A. M., 1906; Ph. D., University of Iowa, 1911.

Percy Edgar Brown. 1914, 1910..........Professor of Soil Bacteriology
B. Sc., Rutgers College, 1906; A. M., 1909; Ph. D., 1912.

Orange Howard Cessna. 1900......Professor of History and Psychology
B. S., Iowa State College, 1872; B. D., Garrett Biblical Institute, 1885; D. D., 1900; A. M., Cornell College, 1901.

Winfred Forrest Coover. 1913, 1904............Professor of Chemistry
A. B., Otterbein University, 1900; A. M., Ohio State University, 1903.

Martin Francis Paul Costelloe. 1916, 1911......Professor of Agricultural Engineering
B. S. in C. E., University of Nebraska, 1906; A. E., 1916.

William Wallace Dimock. 1911, 1909..........Professor of Veterinary Pathology and Bacteriology
B. Agr., Connecticut Agricultural College, 1901; D. V. M., Cornell University, 1905; D. V. M., University of Habana, 1907.

Fred Alan Fish. 1907, 1905..........Professor of Electrical Engineering
M. E. in E. E., Ohio State University, 1898.

Bernard Wernick Hammer. 1916, 1911...Professor of Dairy Bacteriology
B. S. A., University of Wisconsin, 1908.

Harold De Mott Hughes. 1910................Professor of Farm Crops
B. S., University of Illinois, 1907; M. S. A., Univ. of Missouri, 1908.

Allen Holmes Kimball. 1915, 1914........Professor of Structure Design
B. L., University of California, 1910; B. S., Massachusetts Institute of Technology, 1911; M. S., 1912.

Everett Edgar King. 1913, 1911......Professor of Railway Engineering
B. S., Rose Polytechnic Institute, 1901; C. E., 1908; M. S., 1909; A. B., Indiana University, 1910; M. C. E., Cornell University, 1911.

* Absent on leave.

John Edward Kirkham. 1913, 1907...Professor of Structural Engineering
B. S. in C. E., University of Missouri, 1895.

Herman Knapp. 1887, 1883....................................Registrar
B. S. A., Iowa State College, 1883.

General James Rush Lincoln. 1884, 1883....Professor of Military Science
Brigadier General, U. S. Vol., 1898-1899.

Gilmour Beyers MacDonald. 1913, 1910..........Professor of Forestry
B. S. F., University of Nebraska, 1907; M. F., 1914.

Warren H. Meeker. 1907, 1891......Professor of Mechanical Engineering
M. E., Cornell University, 1891.

Martin Mortensen. 1909........................Professor of Dairying
B. S. A., Iowa State College, 1909.

Harlan Bruce Munger. 1914...........Professor of Farm Management
B. S., Cornell University, 1912.

Howard Sylvester Murphey. 1913, 1909........Professor of Veterinary Anatomy and Histology
D. V. M., Ohio State University, 1908.

Alvin Buell Noble. 1898..........................Professor of English
B. Ph., State University of Iowa, 1887.

Louis Hermann Pammel. 1889.....................Professor of Botany
B. Agr., University of Wisconsin, 1885; M. S., 1889; Ph. D., Washington University, St. Louis, 1898.

William Harper Pew. 1912, 1909......Professor of Animal Husbandry
B. S. A., Iowa State College, 1907.

Maria M. Roberts. 1913, 1891..Vice Dean of the Junior College, Professor of Mathematics
B. L., Iowa State College, 1890.

Fredrica Von Trice Shattuck. 1916, 1907....Professor of Public Speaking
B. A., University of Wisconsin, 1905.

Kenneth G. Smith. 1913............Professor of Engineering Extension
A. B., Univ. of Chicago, 1896; B. S. in M. E., Univ. of Illinois, 1905.

Louis Bevier Spinney. 1897, 1891..................Professor of Physics
B. M. E., Iowa State College, 1892; B. S. (E. E.), 1893.

Homer Francis Staley. 1916, 1914....Professor of Mining Engineering
B. A., Ohio State University, 1904.

William Henry Stevenson. 1903, 1902....Professor of Agronomy, Vice Director of Experiment Station
A. B., Illinois College, 1893; B. S. A., Iowa State College, 1905.

*Henry Elijah Summers. 1898.....................Professor of Zoology
B. S., Cornell University, 1886.

George Melvin Turpin. 1913..........Professor of Poultry Husbandry
B. S., in Agr., Utah Agricultural College, 1909.

Samuel Clyde Williams, 1913, 1907........Professor of Physical Training
B. S., University of Iowa, 1901; D. D. S., 1903.

Guy Mitchell Wilson, 1913...........Professor of Agricultural Education
A. B., Indiana University, 1900; M. A., 1908.

* Absent on leave.

Honorable James Wilson. 1913, 1891...Emeritus Professor of Agriculture
M. S. A., Iowa State College, 1907; D. S., 1914; LL. D., University of Wisconsin, 1904; LL. D., University of Edinburgh, 1913.

Associate Professors

Harold Criswell Bartholomew. 1912, 1911........Associate Professor of Electrical Engineering
M. E., in E. E., Ohio State University, 1906.

James Cloyd Bowman. 1914, 1910........Associate Professor of English
B. S., Ohio Northern University, 1905; B. Litt., 1908; A. M., Harvard University, 1910.

Iva L. Brandt. 1914, 1912..........Associate Professor of Domestic Art
B. S. in H. Ec., Iowa State College, 1905.

George Arthur Chaney. 1914, 1913....Associate Professor in Mathematics
M. S., Highland Park College, 1906; M. A., Univ. of Wisconsin, 1910.

Mark Perkins Cleghorn. 1908, 1902...Associate Professor of Mechanical Engineering
B. S. in E. E., Iowa State College, 1902; M. E., 1907.

Frederick Erving Colburn. 1915, 1907—Associate Professor of Photography

Julia Trueman Colpitts. 1913, 1900..Associate Professor of Mathematics
A. B., Mount Allison University, Canada, 1899; A. M., Cornell University, 1900.

Roy Winchester Crum. 1914, 1907...Associate Professor of Experimental Engineering
B. C. E., Iowa State College, 1907; C. E., 1914.

Frank Hamilton Culley. 1915, 1914....Associate Professor of Landscape Gardening
B. Sc., Massachusetts Agricultural College, 1913; M. L. A., Harvard University, 1914.

Morris Irwin Evinger. 1913, 1906......Associate Professor of Hydraulic and Sanitary Engineering
B. C. E., Iowa State College, 1906; C. E., Univ. of Wisconsin, 1913.

J. M. Evvard. 1916, 1910......Associate Professor of Animal Husbandry
B. S. A., University of Illinois, 1907; M. S. A., University of Missouri, 1909.

Henry Ellsworth Ewing. 1916, 1914..Associate Professor of Entomology
B. A., University of Illinois, 1906; M. A., 1908; Ph. D., Cornell University, 1911.

Evan F. Ferrin. 1913, 1911...Associate Professor of Animal Husbandry
B. S. in A. H., Iowa State College, 1911.

Genevieve Fisher. 1915, 1914........Associate Professor of Agricultural Education
B. S., Teachers' College, Columbia University, 1914.

Howard Carlton Ford. 1911, 1907..Associate Professor of Surveying and Astronomy
B. S. (C. E.), Colorado, 1904; M. S., 1905; C. E., 1907.

Chester Charles Fowler. 1913, 1909....Associate Professor of Chemistry
B. S. in Chem. Engr., University of Illinois, 1909; M. S., 1913; Ph. D., Jefferson Medical College, 1915.

Winifred Sarah Gettemy. 1914, 1911..Associate Professor of Domestic Art

Joseph Edward Guthrie. 1913, 1901......Associate Professor of Zoology
B. S., University of Minnesota, 1900; M. S., 1901.

Frank M. Harrington. 1916, 1913....Associate Professor of Horticulture
B. S., Oregon Agricultural College, 1913.

Jaffrey Carl Harris. 1913..................Associate Professor of Music
A. B., Cornell University, 1913.

William Roy Hechler. 1914, 1911....Associate Professor of Farm Crops
B. S. A., University of Missouri, 1911.

Laurence C. Hodson. 1907, 1906..Assoc. Professor of Mining Engineering
B. C. E., Iowa State College, 1899; E. M., Mich. College of Mines, 1901

Kenneth Cole Ikeler. 1915....Associate Professor of Animal Husbandry
M. E., Pennsylvania Normal, 1909; B. S., Pennsylvania State College, 1913; M. S., Iowa State College, 1914.

William Kunerth. 1916, 1907............Associate Professor of Physics
M. A., University of Wisconsin, 1910.

William Gladstone Langwill. 1916.....Associate Professor of Military Science and Tactics
B. S. A., Iowa State College, 1908; First Lieutenant Infantry, U. S. Army, June 3, 1916.

Richard A. Leavell. 1914, 1915........Associate Professor of Mechanical Engineering
B. S. in M. E., Armour Institute, 1910.

Orren Lloyd-Jones. 1914, 1913..Associate Professor of Animal Husbandry
B. S., University of Wisconsin, 1908; M. S., 1911; Ph. D., 1913.

Clyde McKee. 1916, 1913..........Associate Professor of Farm Crops
B. S. in Agr., Kansas State Agricultural College, 1910.

Charles August Mann. 1916......Associate Professor of Chemical Engr.
B. S., University of Wisconsin, 1909; M. S., 1911; Ph. D., 1915.

Charles Curtis Major. 1908..Assoc. Professor of Mechanical Engineering
M. E., Bloom's State Normal School, Pa., 1891; M. E., Cornell University, 1898.

John Nathan Martin. 1912, 1911..........Associate Professor of Botany
A. B., Indiana University, 1907; Ph. D., University of Chicago, 1913.

Charles William Mayser. 1915..Associate Professor of Physical Training

Irving E. Melhus. 1916..........Associate Professor of Plant Pathology
B. Sc., Iowa State College, 1906; Ph. D., University of Wisconsin, 1912.

Ernest Muchmore Mervine. 1915, 1912....Associate Professor of Agricultural Engineering
M. E., University of Lehigh, 1909.

Helen Monsch. 1915..........Associate Professor of Domestic Science
B. S., Kansas Agricultural College, 1904; B. S., University of Chicago, 1909; A. M., Columbia University, 1916.

George Chester Morbeck. 1914, 1912....Associate Professor of Forestry
B. S. in Forestry, Michigan Agricultural College, 1904; M. F., 1915.

Charles Murray. 1913, 1908.....Associate Professor of Veterinary Pathology and Bacteriology
Pe. B., Drake University, 1906; B. S. Iowa State College, 1910; D. V. M., 1912.

Roy A. Norman. 1911, 1907...........Associate Professor of Mechanical Engineering
B. M. E., Iowa State College, 1903; M. E., 1909.

Ernest Alanson Pattengill. 1914, 1900..Assoc. Professor of Mathematics
B. S., Iowa State College, 1897; B. S., Cornell University, 1899.

Ralph S. Potter. 1916, 1913..................Associate Professor of Soils
A. B., Lake Forrest College, 1909; M. S., University of Illinois, 1911; Ph. D., 1913.

John Owen Rankin. 1916..........Associate Professor of Agricultural Economics
A. B., Tarkio College, 1904; B. S. A., Iowa State College, 1908; M. A., George Washington University, 1912.

William Randolph Raymond. 1912, 1907..Associate Professor of English
A. B., Grinnell Collee, 1894.

Raemer R. Renshaw. 1914, 1913..Assoc. Professor of Organic Chemistry
B. S., University of Oregon, 1902; M. S., 1903; Ph. D., Columbia University, 1907.

Arthur William Rudnick. 1916, 1913..Associate Professor of Dairying
B. S., Iowa State College, 1910.

Louis Bernard Schmidt. 1911, 1906......Associate Professor of History
Ph. B., Cornell College, 1901; A. M., 1906.

William Elmer Sealock. 1915........Associate Professor of Agricultural Education
A. B., University of Ohio, 1905.

Phineas Stevens Shearer. 1914, 1912......Associate Professor of Animal Husbandry
B. S. in A. H., Iowa State College, 1912.

Roy Eugene Smith. 1914, 1909..............Associate Professor of Soils
B. S. A., Iowa State College, 1909; M. S., 1911.

George Waddel Snedecor. 1914, 1913..Associate Professor of Mathematics
B. S., Univ. of Alabama, 1905; M. A., Univ. of Michigan, 1912.

Harold Stiles. 1915, 1914...............Associate Professor of Physics
A. B., Kenyon College, 1896; A. M., Harvard University, 1904; Ph. D., Northwestern University, 1909.

Louis Agassiz Test. 1914, 1913........Associate Professor of Chemistry
B. M. E., Purdue University 1894; A. C., 1896; Ph. D., University of Chicago, 1907.

George Ellsworth Thompson. 1915, 1914...Associate Professor of Physics
A. B., Indiana University, 1909; A. M., 1910; Ph. D., Cornell University, 1913.

Thomas Franklin Vance. 1916, 1914..Associate Professor of Psychology
A. B., Coe College, 1909; M. A., University of Iowa, 1911; Ph. D., 1913.

Henry William Vaughan. 1914, 1913..Assoc. Prof. of Animal Husbandry
B. S. in Agr., Ohio State University, 1908; M. S. in Agr., 1909.

George Henry Von Tungeln. 1914, 1913..Assoc. Prof. of Rural Sociology
Ph. B., Central Wesleyan College, 1909; M. A., Northwestern University, 1910.

John Anderson Wilkinson. 1914, 1913.....Associate Professor of Physical Chemistry and Inorganic Analysis
B. Sc., Ohio State University, 1903; Ph. D., Cornell University, 1909.

Charles A. Wright. 1915...Associate Professor of Electrical Engineering
B. E., Tulane University, 1906; E. E., 1909; M. E. E., Harvard University, 1910.

Assistant Professors

John Hampton Atkinson. 1914....................................English
Ph. B., Ohio University, 1897; A. M., Columbia University, 1901.

Arthur Laurence Bakke. 1913, 1910..............................Botany
B. S., Iowa State College, 1909; M. S., 1911.

Ross Leon Bancroft. 1915...Soils
B. S., University of Wyoming, 1914; M. S., Iowa State College, 1915.

John Thaxter Bates. 1910, 1907................Mechanical Engineering
B. S. in M. E., University of Maine, 1907.

Rudolph Ray Bolton. 1914............Veterinary Practice and Diagnosis
A. B., Ohio University, 1909; D. V. M., Cornell University, 1912.

Frank Emerson Brown. 1917...............................Chemistry
A. B. Kansas State Normal School, 1911; S. B. University of Chicago, 1913.

John Hall Buchanan. 1915, 1911...............................Chemistry
B. S., Iowa State College, 1911; M. S., 1915.

Ollison Craig. 1915............................Mechanical Engineering
B. S. in M. E., University of Illinois, 1909.

Louis De Vries. 1916, 1913........................Modern Languages
A. B., Central Wesleyan College, 1907; A. M., Northwestern University, 1908.

Vera Morlan Dixon. 1916..Library
B. S., Iowa State College, 1908.

Charles S. Dorchester. 1916, 1913..........................Farm Crops
B. S. in Agron., Iowa State College, 1913.

Eric Eyre Eastman. 1916, 1913...................................Soils
B. S., Iowa State College, 1913; M. S., 1915.

Annie Wilson Fleming. 1915, 1900........................Mathematics
B. S., Iowa State College, 1894.

Sidney Longman Galpin. 1913....................................Geology
A. B., Western Reserve University, 1907; A. M., Cornell University, 1910; Ph. D., 1912.

Heber Howard Gibson. 1915.....................Agricultural Education
A. B., Denison University, 1909; M. A., Columbia University, 1912.

Lester S. Gillette. 1915, 1914..........................Dairy Husbandry
B. S. in A. H., Iowa State College, 1913; A. M., University of Missouri, 1914.

LeRoy Bethuel Greenfield. 1914..................................English
B. A., Univ. of Oklahoma, 1903; Ph. M., Univ. of Chicago, 1906.

Willard F. Guard. 1916, 1914..........Veterinary Surgery and Obstetrics
D. V. M., Ohio State University, 1912.

*Ralph Edwin Hall. 1916....................................Chemistry
B. S., Ohio Wesleyan University, 1907; M. A., Ohio State University, 1911; Ph. D., University of Chicago, 1916.

Bruce Magill Harrison. 1913, 1910..............................Zoology
B. S., Ottawa University, 1905; M. S., University of Illinois, 1908.

Arthur John Hauser. 1916, 1913................................Dairying
B. S. in Agr., Pennsylvania State College, 1911.

John Hug. 1913, 1909..........................Mechanical Engineering
B. M. E., Iowa State College, 1909.

Jesse Greenleaf Hummel. 1910, 1903..............Mechanical Engineering
B. M. E., Iowa State College, 1902; M. E., 1914.

Jane Agnes Humphrey. 1915........................Home Economics

Harry Mervin Lackie. 1916, 1914...................Poultry Husbandry
B. S. in Ag. Ed., Iowa State College, 1915.

Max Levine. 1914, 1913.....................Bacteriology and Hygiene
B. Sc., Massachusetts Institute of Technology, 1912.

Wylle B. McNeal. 1916, 1915........................Home Economics
B. S. in Ed., University of Chicago, 1915.

Ned A. Merriam. 1913...............................Physical Training

Nelson Louis Nelson. 1915, 1911......Veterinary Practice and Diagnosis
D. V. M., Iowa State College, 1911.

Harry Russell O'Brien. 1915..................Agricultural Journalism
B. A., Ohio State University, 1910; M. A., 1912.

Anna Margrethe Olsen, 1916, 1915.....................Home Economics
B. Sc., Columbia University, Teachers' College, 1912.

Oscar Anton Olson. 1915, 1913................Mechanical Engineering
B. M. E., Iowa State College, 1908; M. E., Iowa State College, 1914.

Frank D. Paine. 1913, 1912....................Electrical Engineering
B. S. in E. E., Iowa State College, 1909.

Herbert John Plagge. 1913, 1909..............................Physics
B. S., Northwestern Univ., 1906; M. A. Univ. of Wisconsin, 1910.

Frank Anson Robbins. 1912, 1910...............Electrical Engineering
A. B., Yankton College, 1907; B. S., University of Illinois, 1910.

Raymond Willard Rogers. 1915......................Physical Training
B. P. E., Springfield College, 1910.

Herman A. Scullen. 1914...................................Zoology
A. B., University of Oregon, 1910.

Arthur S. Thurston. 1916..............................Horticulture
B. Sc., Massachusetts Agricultural College, 1914; M. Sc., 1916.

Winifred Richards Tilden. 1908, 1904...............Physical Director
B. A., Mount Holyoke, 1903.

Dora Gilbert Tompkins. 1908, 1905...........................English
A. B., Monmouth College, 1893; A. M., Knox College, 1898.

Thomas Roy Traux. 1915, 1913...............................Forestry
B. S., Iowa State College, 1912.

*Resigned February, 1917.

Rolland Schanel Wallis. 1913, 1911....................Civil Engineering
B. S. in E. E., Iowa State College, 1907; B. S., in C. E., 1911; C. E., 1915.

Harter Walter. 1914..................................Physical Training
A. B., Wabash College, 1909.

Polly Witwer. 1916...................................Home Economics
B. S. in H. Ec., Iowa State College, 1912; A. M., Columbia University, 1916.

Instructors

Homer George Anderson, B. S..............................Physics, 1914
Raymond Arthur Anderson, Ph. B..........................English, 1916
Alexander Vasey Arragon, A. B., A. M....................History, 1915
**John M. Arthur..Botany, 1916
Archibold Bailey...Music, 1916
Walter Earl Baker, A. B.......................Economic Science, 1916
Elza Gordon Bassett, A. B.....................Modern Language, 1913
Charles Alton Baughman, B. S. in C. E..........Civil Engineering, 1909
Louis Jacob Bircher, A. B., B. S. in Ag. Ed.............Chemistry, 1916
Harl Boileau, B. S. in M. E..............Mechanical Engineering, 1916
Alma B. Booth...............................Home Economics, 1913
Reuben Wesley Brown, B. S. A..........................Dairying, 1915
John James Brunner.......................................Dairying, 1916
Helen Alice Burling, B. S., M. S.................Bacteriology, 1913
Grace Caldwell.................................Home Economics, 1915
James William Cameron..................Mechanical Engineering, 1907
Grace Campbell, B. S..............................Mathematics, 1914
William Glasgow Bruce Carson, A. B., A. M..............English, 1916
Dean G. Carter, B. S. in A. E............Agricultural Engineering, 1916
Janet Grace Cation, Ph. B.......................Home Economics, 1916
Steward Chandler, Ph. D...........................Modern Language, 1916
Vivian Leroy Chrisler, A. B., B. S., M. A................Physics, 1916
Richard Ruben Clem.....................Agricultural Engineering, 1911
Florence Lathrop Coolidge, A. B., M. A..................English, 1916
Marian Elizabeth Daniells, A. B...................Mathematics, 1914
Edward William Dolch, Jr., A. B.........................English, 1915
Hiram S. Doty, B. S., M. S.........................Botany, 1912, 1911
John Frederick Howard Douglas, S. B., Ph. D.............Physics, 1914
*Frank A. Dragoun, B. S. in C. E...............Civil Engineering, 1913
J. Lawrence Eason, A. B., A. M..........................English, 1915
Ruth Edgerton, B. S. in Physical Education......Physical Culture, 1914
Albert Franklin Edminster, B. S., M. S..............Horticulture, 1916
George V. Emery, B. A....................................Physics, 1914
Honora English, B. S...............................Domestic Art, 1916
*Mrs. Mary Peters Fairfield, B. A.............Modern Language, 1908
Fay Farnum, B. S., M. A............................Mathematics, 1915

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* Absent on leave.
** Temporary service, three months for A. L. Bakke, Asst. Prof.

Elizabeth Genevieve Fuller, A. B. .... English, 1916
G. H. Godfrey, B. S. .... Botany, 1916
Helen Ried Goodrich .... Domestic Art, 1913
Mrs. L. B. Greenfield, A. B. .... English, 1916
James Daniels Grossman, G. Ph., D. V. M. ... Veterinary Anatomy, 1914
Helena C. L. Hanson, B. S. .... Home Economics, 1916
*Ada Hayden, B. S., M. S. .... Botany, 1910
Maurice D. Helser, B. S. A., M. S. in A. H. .... Animal Husbandry, 1916
Anna M. Henderson .... Home Economics, 1916
Henry F. Hertz .... Agricultural Engineering, 1915
Otto A. Herzog, A. B., A. M. .... Modern Language, 1915
Roy J. Holmes, Ph. B. .... English, 1916
P. F. Hopkins, B. S. in C. E. .... Civil Engineering, 1916
Frederick Franklin Householder, B. A. .... Physics, 1914
Blanche Ingersoll, B. S. .... Home Economics, 1915
Margaret Elizabeth Irving, A. B. .... Public Speaking, 1914
Palma Iverson, B. A. .... Mathematics, 1916
Harlan Woodbridge Johnson, B. S., M. S. .... Soils, 1915
George Judisch .... Veterinary Pharmacology, 1912, 1901
Edward W. Kane, B. S. .... Electrical Engineering, 1916
Rosemond Harriet Kedzie, B. S. .... Home Economics, 1913
James Byron Kelley, B. S. in M. E., B. S. in A. E. .... Agr'l Engr., 1912
Lena Jessamine Krakau, A. B., A. M. .... Public Speaking, 1916, 1915
Elizabeth Annis Lathrop .... Domestic Art, 1916
Robert Jens Leth, B. S., M. S. .... Farm Management, 1916, 1915
G. E. Linden .... Physical Training, 1914
Ingeborg G. Lommen, M. L. .... Modern Language, 1907
Jessie McArthur, B. A., M. A. .... English, 1914
Daniel McKay, Jr., B. S. in Hort. .... Horticulture, 1916
Elizabeth McKim, B. S. .... Mathematics, 1913
Nina Madsen, B. S. .... Mathematics, 1916, 1915
Frank Eric Millen, B. Sc. A. .... Zoology, 1917
Cora B. Miller, B. S. .... Home Economics, 1916
Cecelia Elizabeth Murray, B. S. .... Domestic Art, 1916
Boyd Simonton Myers, B. S. in C. E., C. E. .... Civil Engineering, 1914
Nellie M. Naylor, B. A. .... Chemistry, 1909
William Neuswanger, B. A., M. A. .... Physics, 1915
Alois F. Nickels .... Mechanical Engineering, 1911
Amy W. Noll, B. Ph. .... General Library, 1914, 1912
Grace Isabel Norton, B. A. .... Modern Language, 1901
Ruth O'Brien, B. S., M. A. .... Chemistry, 1916
Francis Philo, B. A. .... Physical Culture, 1915
John Calvin Pomeroy, B. A., M. A. .... Physics, 1912
Ezra Cornelius Potter .... Mechanical Engineering, 1898
Betty Huston Pritchett, A. B. .... Library Cataloguer, 1915, 1912
Reuben Charles Riedesel, B. M. E. .... Mechnical Engineering, 1912
Willard Allen Roberts, B. S., Ph. D. .... Chemistry, 1916

* Absent on leave.

Louis A. Rumsey, M. S. . . . . Chemistry, 1914
Ruth Bogardus Safford, B. L. . . . . English, 1908
James R. Sage, Jr., A. B., M. S. . . . . Mathematics, 1915
Charles F. Salt, B. S., B. A. . . . . Agricultural Journalism, 1915
Lewis Ralph Sanders . . . . Dairy, 1916
John A. Sawin . . . . Mechanical Engineering, 1907
Werner John Suer, B. A. . . . . Chemistry, 1914
Helen Florence Smith, A. B. . . . . Mathematics, 1907
Edward Merritt Spangler . . . . Mechanical Engineering, 1905, 1904
Harold Greene Sprague, B. S. in Architecture . . . . . . Structure Design, 1915
Arward Starbuck, A. B. . . . . English, 1913
Louis Martin Starin, A. B. . . . . Zoology, 1915
Ingeborg Svendsen-Tune . . . . Music, 1913
*Laura May Taggart, B. S. . . . . Chemistry, 1907, 1906
A. Helen Tappan, A. B., A. M., Ph. D. . . . . Mathematics, 1914
Orville C. Ufford, B. S. in A. H. Animal Husbandry, 1914
Donald Parker Weeks, Jr., B. Sc. in A. E. . . . . Agr'l Engineering, 1916
Wallace M. Welty, B. S. . . . . Horticulture, 1916
Herbert Ralph Werner, Ph. B., Ph. M., A. M. . . . . Zoology, 1914
Maurice H. Weseen, A. B. . . . . English, 1914
Roy Olin Westley, B. S. in Agronomy . . . . Farm Corps, 1915
Franklin Scott Wilkins, B. S., M. S. . . . . Farm Corps, 1914
Robert Wylie, B. S. in Agr., A. M. . . . . Dairy Husbandry, 1916
Lawson Edwin Yocum, B. S. . . . . Botany, 1916

Assistants

D. F. Anderson . . . . Pharmacist, Veterinary Surgery, 1916
Myron Sallee Anderson, A. B., M. S. . . . . Chemistry, 1916
Hazel Baker, B. S. . . . . Domestic Art, 1916
Alpheus W. Blizzard, B. S., A. M. . . . . Zoology, 1916
Oliver Wendall Chapman, B. A. . . . . Chemistry, 1916
Hazel Kirk Chisman . . . . General Library, 1915
Ira D. Clarke, A. B. . . . . Chemistry, 1915
Clarissa Clark, B. S. . . . . Bacteriology, 1917
Nora E. Cordingly, B. A. . . . . Assistant Cataloguer, 1916
**George Gorham DeBord, B. S., M. S. . . . . Bacteriology, 1916, 1915
Agnes Fleming, A. B. . . . . Veterinary Library, 1915
L. C. Gruwell . . . . Mechanician, Agr'l Engr. and Mech. Engr., 1916
J. G. Hanmer . . . . Farm Superintendent, 1914
Joseph William Hawkes, B. S. . . . . Chemistry, 1916
Anson Hayes, B. S. . . . . Chemistry, 1915
Helen Marion Hossfeld . . . . General Library, 1915
Horace D. Irish, Ph. C. . . . . Chemistry, 1915
Delta May Kauffman, A. B. . . . . Public Speaking, 1916
Thomas O. Kellems, B. S. . . . . Chemistry, 1915
L. M. Kelley . . . . Agricultural Engineering, 1911

* Absent on leave.
** Resigned January, 1917.

Raymond Eller Kirk, B S. . . . . Chemistry, 1915
Caroline Laird. . . . . Engineering Library, 1907
Thomas Seeter Leith, D. V. M. . . . . Veterinary Anatomy, 1916
R. C. Louck, D. V. M. . . . . Veterinary Pathology, 1916
Henry Max McLaughlin, B. S., M. A. . . . . Chemistry, 1915
George A. Minges, B. S. . . . . Chemistry, 1916
John Arthur Montgomery, A. B. . . . . Chemistry, 1915
Mrs. Sue B. More, B. A., B. S. . . . . Chemistry, 1914
N. C. Pervier, B. S. . . . . Chemistry, 1916
Robina Rae. . . . . Agricultural Library, 1909
John Reardon. . . . . Horticulture, 1909
Marie Theresa Rees, Ph. B. . . . . Botany Library, 1916
Ivan Lincoln Ressler, A. B. . . . . Zoology, 1915
A. O. Smith. . . . . Mechanician Civil Engr., 1916
Frank H. Schoultz, B. S. . . . . Chemistry, 1914
Dwight L. Scoles, B. S. . . . . Chemistry, 1915
Mrs. Grace E. Smith, Ph. B. . . . . Chemistry Library, 1915
Earl F. Tovrea, B. S. . . . . Chemistry, 1916
Earl R. Waffle, B. S. . . . . Chemistry, 1915
Zelma Zentmire, B. S., M. S. . . . . Chemistry, 1914

Fellows and Scholars

James Ralph Burkholder, B. S. . . . . Zoology, 1916
Alfred B. Caine, B. S. . . . . Animal Husbandry, 1916
Henry Hugh Dukes, B. S. . . . . Veterinary Physiology, 1915
A. B. Gwinn, B. S. in Agr. . . . . Soils, 1916
Frank Alfred Hays, B. S., M. A. . . . . Animal Husbandry, 1915
Earl A. Hewitt, A. B., B. S. . . . . Veterinary Anatomy, 1915
H. W. Hulbert, B. S. . . . . Farm Crops, 1916
J. B. Kendrick, B. S. . . . . Botany, 1916
Nana Kenoyer, A. B. . . . . Botany, 1916
Robert Stearns Kirby, B. S. . . . . Horticulture, 1916
Harvey L. Lantz, B. S. . . . . Horticulture, 1916
Ross L. Laybourn, B. S. . . . . Bacteriology, 1916
Emery F. McKune, B. S. . . . . Horticulture, 1916
Mark Humbert Middlekauff, B. S. . . . . Bacteriology, 1916
Cap Earl Miller, B. A. . . . . Economic Science, 1916
Ralph A. Moye, B. A. . . . . Veterinary Anatomy, 1915
George Parker Pritchett, B. S. in Ind. Sci. . . . . Physics, 1916
Henry R. Richardson, B. S. . . . . Agricultural Engineering, 1916
Jacob Rovner, B. S. in Agr. . . . . Dairying, 1916
Frank Hazelton Smith, B. Sc. in Ent. . . . . Zoology, 1916
Laurence Vincent Starkey, B. S. in Agr. . . . . Animal Husbandry, 1916
Grover Dean Turnbow, B. S. in Agr. . . . . Dairying, 1916
Harry W. Warner, B. S. . . . . Soils, 1916
Jay Whitson, B. S. in Agron. . . . . Farm Management, 1916
Harry Burdett Winchester, B. S. . . . . Animal Husbandry, 1916

Student Assistants

J. F. Bisig	Botany, 1915
Harold James Cree	Horticulture, 1915
A. Davis	Veterinary Surgery, 1916
E. N. Dudley	Agricultural Engineering, 1916
W. H. Frakes	Veterinary Physiology, 1916
F. E. Fuller	Farm Crops, 1916
Evan A. Hardy	Agricultural Engineering, 1916
Mark Havenhill, B. S.	Agricultural Engineering, 1914
Irene Henderson, A. B.	Botany, 1916
David R. Johnson, B. S. A.	Soils, 1916
Carl Kurtzweil	Botany, 1916
W. M. McLeod	Veterinary Anatomy, 1916
G. W. McNutt	Veterinary Pathology and Bacteriology, 1916
S. H. McNutt	Veterinary Pathology and Bacteriology, 1916
A. R. Stephenson	Veterinary Pathology and Bacteriology, 1916
E. W. Stillwell	Horticulture, 1915
Frank Walsh	Veterinary Anatomy, 1916
Bruce Warwick	Veterinary Anatomy, 1916

Admission to the College

Applications for credential blanks and all communications with regard to the admission of any student to the College should be addressed to the Registrar. Official high school records should be filed with the Registrar at the close of the school year, if possible, and not later than the second Monday in August or the first Monday in January. The Registrar will determine the value of all credentials and will notify the applicant of their acceptance. He will also assign the applicant for admission to his position in the course desired. This assignment will be conditioned upon the student's doing creditable work.

Applicants for admission to the freshman classes should be at least sixteen years of age and must present satisfactory evidence of having completed the preparatory studies required for admission to the course desired.

A student may enter the College at the beginning of either semester. Those wishing to enter at the beginning of the second semester should find out from the Registrar whether entrance at that time is feasible in their case. The regular classes begin with the opening in September and the student is urged to commence at that time. Some freshmen subjects are, however, taught in both semesters. The freshman work will be of such grade that the graduate of an accredited high school can reasonably be determine the value of all credentials and will notify the applicant of their expected to carry it creditably. The responsibility of maintaining himself in the freshman class rests, however, upon the student. The College desires to emphasize the importance of thorough preparation, particularly in subjects that are to be continued in College, for example, in mathematics and English. In these subjects the College has found it helpful to conduct a review at the beginning of the year. Students who are found to be inadequately prepared are assigned to a less advanced section, or otherwise helped to make up the deficiency. Since without thorough preparation satisfactory progress is impossible, students are urged to review carefully, before entering College, algebra through quadratics and English composition and grammar. Those desiring admission should examine *Requirements for Admission* (page 27), *Methods for Obtaining the Fifteen Units* (page 30), and especially the method of study and the attainment desired in the respective subjects set forth under *General Statement Concerning Entrance Units* (page 35).

ACCREDITED SCHOOLS

High schools and academies are placed on the accredited list upon the recommendation of the Board of Secondary School Relations, and upon the approval of the faculties of the three state educational institutions of

Iowa. The Board on Secondary School Relations was appointed by the Iowa State Board of Education.

All questions with regard to inspection of the schools or their relation to the three state institutions should be addressed to John E. Foster, Inspector, State Board of Education, Des Moines, Iowa.

REQUIREMENTS FOR ADMISSION TO THE SEVERAL DIVISIONS OF THE COLLEGE

(For admission to Graduate Division, see page 68)

(For requirements for Non-Collegiate Courses, see page 351)

The requirements for admission are stated in terms of units. An entrance unit is defined as thirty-six weeks of high school work in one subject of study, with five class periods per week, each not less than forty minutes in length. Each laboratory period should be at least eighty-five minutes in length. Students desiring admission to the Freshman year must present fifteen units. Of these, certain are required and the others may be elective.

***Units Required for Admission**

	Division of Agriculture Units		Division of Engineering Units		Division of Home Economics Units		Division of Industrial Science Units		Division of Veterinary Medicine Units	
Groups—										
1 English	3		3		3		3		3	
2 History, Civics, Economics	1		1		1		1		1	
3 Foreign Language**	..		2		2		2		..	
4 Mathematics										
Algebra	1½	2½	1½	3	1½	2½	1½	2½	1½	2½
Geometry, Plane	1		1		1		1		1	
Geometry, Solid	...		½		...		...		...	
5 Natural Sciences	..		..		..		..		..	
6 Additional requirements in the above groups 1, 2, 3, 4, and 5: of these groups two must have 3 units each, and the five groups much have a minimum total of 11 units	4½		2		2½		2½		4½	
Minimum total	11		11		11		11		11	
7 Electives	4		4		4		4		4	
Total units required for admission	15		15		15		15		15	

* A student may enter by meeting either the old or the new requirements until he registers for the year 1919, when the new requirements will be in full force.

** In the divisions of Engineering and Industrial Science the two required units must be in one foreign language. In the other divisions the students are urged to meet this standard.

Conditional Admission

A student who presents fourteen (14) acceptable units may be conditionally admitted to the Freshman year. He shall be classified in the deficient work as a part of the normal amount of work allowed to students, and must remove the condition before classification for the second year's work. Students will not be permitted to remove entrance conditions by taking an examination in any subject which they have pursued in the College.

Exception to this rule: In case a student presents fifteen (15) acceptable entrance units, not including foreign language (where foreign language is required), he shall be conditioned in foreign language and may postpone the making up of the condition until the beginning of the Junior year, when he will be classified in the subject. To remove the condition, if the subject is taken in College, will require extra work to the extent of five hours a week for two semesters.

List of Subjects

Entrance units may be allowed as indicated below, subject also to the above table as to the amount of any subject which can be used toward the 15 units. No credit will be given for less than one-half unit in any single subject.

Group 1. ENGLISH.

(1) A total of not more than 4 units, including the required 3 units. Not less than 3 semesters in Literature; and 3 semesters in Composition, Rhetoric, and Grammar, except that no credit will be given for Grammar if taken before the eleventh grade.

Group 2. HISTORY, CIVICS, AND ECONOMICS.

(1) A total of not more than 4 units, including the required unit, and not more than the maximum credit here indicated in each case; except that no credit will be given for United States History if taken before the eleventh grade.

(a) Ancient History	½ to 1 unit
(b) Medieval and Modern History	½ to 1 unit
(c) English History	½ to 1 unit
(d) United States History	½ to 1 unit
(e) General History (but not in addition to Medieval and Modern History)	1 unit
(f) Civics	½ to 1 unit
(g) Political Economy	½ unit

Group 3. FOREIGN LANGUAGE.

(1) A total of not more than 4 units in any one foreign language, including the required 2 units. No credit will be given for less than one unit in any foreign language.

(a) Greek	2 to 4 units
(b) Latin	2 to 4 units

(c) French	2 to 4 units
(d) Spanish	2 to 4 units
(e) German	2 to 4 units
(f) Scandinavian	2 to 4 units

Group 4. MATHEMATICS.

(a) Algebra (required)	1½ units
(b) Plane geometry (required)	1 unit
(c) Solid geometry	½ unit
(d) Plane trigonometry	½ unit
(e) Advanced Algebra	½ unit
(f) Advanced Arithmetic (no credit can be given for arithmetic unless taken in the third or fourth year of the secondary school course or after the completion of 1½ units in algebra)	½ unit

Group 5. NATURAL SCIENCES.

(1) A total of not more than 4½ units will be accepted in this group.

(a) Agriculture Plant Industry Animal Industry Rural Economics General Agriculture	½ to 2 units
(b) Astronomy	½ unit
(c) Biology, elementary	½ to 1 unit
(d) Botany	½ to 1 unit
(e) Chemistry, not less than	1 unit
(f) General Science	½ to 1 unit
(g) Geology	½ unit
(h) Physical Geography or Physiography	½ to 1 unti
(i) Physics, not less than	1 unit
(j) Physiology	½ unit
(k) Zoology	½ to 1 unit

Group 6. ADDITIONAL REQUIRED WORK (see table above).

Group 7. ELECTIVES. Whatever work to the extent of four additional units the accredited school certifies as accepted by that school for graduation; subject to the definitions of units of entrance credit adopted by the North Central Association of Colleges and Secondary Schools, or in bulletins published by the Iowa Board on Secondary School Relations. A total of not more than 4 units will be accepted in commercial, industrial, and miscellaneous subjects.

(1) Commercial subjects.

(a) Business arithmetic (not in addition to advanced arithmetic, and only if taken after the completion of the required 1½ units in algebra or in the latter half of the high school course)	½ unit
(b) Elementary bookkeeping	½ to 1 unit

(c) Advanced bookkeeping	½ to 1 unit
(d) Commercial law	½ unit
(e) Stenography and typewriting	1 to 2 units
(f) Business correspondence	½ unit
(g) History of commerce	½ unit
(h) Economic history of England	½ unit
(i) Economic history of United States	½ unit
(j) Materials of commerce	½ unit
(k) Commercial geography	½ unit
(2) Industrial subjects	
(a) Freehand or Mechanical Drawing	½ to 2 units
(b) Manual Training, i. e., shop work	½ to 4 units
(c) Domestic Science	½ to 2 units
(3) Miscellaneous.	
(a) Public speaking.	½ unit
(b) Bible	½ to 1 unit
(c) Music	½ to 2 units
(d) Agriculture—additional units	½ to 2 units
(e) Psychology	½ to 1 unit
(f) Pedagogy and methods	½ to 1 unit

METHODS FOR OBTAINING THE FIFTEEN UNITS

There are four methods of obtaining the necessary units for admission to the Freshman class:

A. Admission by transfer from other colleges and universities.
B. Admission by certificate from fully accredited high schools.
C. Admission from unaccredited high schools.
D. Admission by examination and on other evidences of proficiency.

A. Admission by Transfer From Other Colleges and Universities

Students of other colleges will be admitted to advanced standing in this college under the following conditions:

First, they must present a letter of honorable dismissal.

Second, the entrance requirements to the college must be fully satisfied.

Third, students of other colleges will be admitted and granted such credits as their work will justify. Work of recognized merit that has been taken at Colleges and Universities of good rank and standing will be credited for an equivalent amount of work so far as it applies in any of the courses offered at this College. Students taking up work in this way will present official records to the Advanced Standing Committee at the Registrar's Office to ascertain the credits to be allowed. It will be understood between the applicant and the Committee that the credits are only provisionally accepted and that their final acceptance depends wholly upon the student's maintaining a good average standing for one year in Iowa State College.

Fourth, it is required that all credits from other institutions be sent by the proper officers of such institutions, duly certified, to the Registrar of this College, such certificates to include the number of weeks the student has pursued the studies in question and the number of hours' credit received in each term, as well as the portions of the subjects covered.

Fifth, advanced or college credit may be given for extra high school or secondary school work only on the following conditions:

1. The number of units reported and accepted must be in excess of 16.
2. There must be a rigorous examination for college credit.

B. Admission by Certificate From Fully Accredited High Schools

Graduates of fully accredited high schools of Iowa who meet fully the requirements for admission to the Freshman class, will, upon presentation of the proper uniform certificate, be admitted to the College without examination.

Graduates of schools fully accredited by the colleges of other states which have as high a standard of entrance requirements as this institution, will also be admitted as freshman upon presentation of certificate of graduation, accompanied by uniform admission certificate.

Superintendents and principals are urged to send to the Registrar immediately upon the close of the school year, the uniform admission certificate of each graduate intending to enter the College at the beginning of the ensuing College year. If on inspection the certificate is found satisfactory, the applicant will be forwarded a certificate entitling him to admission without examination. Uniform admission certificates may be obtained by teachers and students who are candidates for admission to the College upon application to the Registrar. The certificate must show the grade of work done and text-books used in the subjects required for entrance, with a definite statement of the year of the high school in which the subject was taken, the number of recitations per week, and the number of weeks the subject was pursued during the high school course; and it must state that the applicant is of good moral character and, in the judgment of the subscriber, able to pursue college studies successfully.

If, however, applicants from accredited four-year secondary schools present the superintendent's or principal's certificate showing deficiencies not exceeding one entrance unit, together with that officer's statement that they are in good standing in the school from which they come, and that in the subscriber's judgment they are able to pursue college studies successfully, they may be admitted on condition that they make up enough credits to bring the number up to fifteen units within one year after their admission.

Diplomas of graduation will not be accepted for entrance unless accompanied by a uniform certificate as stated above.

Applicants planning to enter by certificate will be saved much trouble and annoyance, and possibly delay, by mailing their certificates in advance to the Registrar as soon as they have decided to make application. All preliminary adjustments can be made by correspondence, at the close of

which the successful applicant will be in possession of an entrance card which he will need only to present to the Treasurer for registration and to the Dean for classification.

All uniform certificates should be filed with the Registrar not later than the second Monday in August or the first Monday in January.

C. Admission from Unaccredited High Schools

A student presenting a certificate from an unaccredited school may be admitted to collegiate courses by the following plan:

(1) He is to pass entrance examinations in acceptable subjects representing each of the main groups of subjects certified, for one-third of the number of acceptable credits so certified.

(2) The subjects for examination are to be selected by the college examiner at the time of the examination and irrespective of the choice of the student.

Each year, on the first Tuesday of May and the Monday preceding, college entrance examinations may be held in any unaccredited four-year high school applying for such examinations. The Inspector of Secondary Schools for the State Board of Education, Des Moines, Iowa, sends to the Superintendents of the unaccredited high schools of Iowa for their supervision the entrance examinations for the applicants who desire admission to the three state institutions. All papers, together with the examination questions used, should be sent to the Inspector.

In case the student fails in one or two groups of the subjects he may take another examination at the regular time set for the examinations in September and at the institution to which the student seeks admission.

(3) The total number of credits ultimately allowed on the certificate shall not exceed three times the number earned by examination.

(4) The total amount of credit gained in this way, together with additional credit for subjects not indicated in the certificate (or subjects so indicated, but not acceptable), if additional credit is needed, shall be at least 14 units. In case the student presents less than fifteen acceptable entrance units he is to be conditioned to the extent of enough units to bring the total number up to fifteen units.

D. Admission by Examination and on Other Evidences of Proficiency

ADMISSION BY EXAMINATION

(A suggestive list of examination questions may be obtained from the Registrar.)

Students who desire to enter by examination and who present satisfactory evidence that they have devoted sufficient time to preparation, will be given examinations in any subjects required for entrance.

Students desiring to enter by examination will be expected to pass examinations in the required and elective subjects, according to work outlined on pages 27 to 30.

The subject matter to be covered is according to the material found under the general statement concerning entrance units, page 35, which gives a synopsis of the amount and kind of work required for entrance.

COLLEGE ENTRANCE EXAMINATIONS

Certificates of entrance examinations passed for admission to reputable Universities and Colleges, and certificates of examination passed under the direction of any of the College Entrance Examination Boards and the Regents of the State of New York, may be accepted as are accepted the certificates from our own accredited schools.

ACADEMIES AND PREPARATORY SCHOOLS

Credits certified from private secondary schools such as academies and seminaries, and from college preparatory schools, shall be estimated in accordance with the definition of the entrance unit and on the standard of four years of preparation and residence. College academies or preparatory departments conforming in their organization with the organization of the four-year accredited high school shall be treated as accredited schools, if the colleges themselves are regarded as standard colleges.

FIRST GRADE UNIFORM COUNTY CERTIFICATE

Entrance credit may be allowed for the first grade uniform county certificate in subjects marked 85 or above, as follows:

Arithmetic	½ unit	Economics	½ unit
U. S. History	½ "	Algebra	1 "
Physiology	½ "	Agriculture	½ "
Grammar	½ "	Domestic Science	½ "
Civics	½ "		

STATE CERTIFICATE

Entrance credit may be allowed without examination for the five-year second and first grade state certificates, and for the life diploma as follows:

	SECOND GRADE	FIRST GRADE	LIFE DIPLOMA
English	1½ units	3 units	3 units
History	½ "	1½ "	1½ "
Civics	½ "	½ "	½ "
Economics	½ "	½ "	½ "
Algebra	1½ "	1½ "	1½ "
Arithmetic	½ "	½ "	½ "
Bookkeeping	½ "	½ "	½ "
Physics	1 "	1 "	1 "
Botany	½ "	½ "	½ "
Physiology	½ "	½ "	½ "
Drawing	½ "	½ "	½ "
Didactics	½ "	½ "	½ "
Psychology		½ "	½ "

2

Geometry		1 unit	1 unit
Trigonometry		....	½ "
Astronomy		....	½ "
Geology		....	½ "
Zoology		....	½ "
Totals	8½ units	12½ units	14½ units

ENTRANCE EXAMINATION PROGRAM

The scope of the entrance examinations is indicated in the "General Statement Concerning Entrance Units," pages 35 to 45.

Admission to the entrance examinations is by permit. Permits may be obtained of the Registrar, Room 125, Central Building.

A representative from each department will conduct the examinations in Room 102, Central Building, on Thursday and Friday preceding classification.

Any student finding a conflict in his program should report to the Registrar for adjustment.

Graduates of the unaccredited schools of the State should take the entrance examinations in May according to the instructions set forth on page 32.

Thursday:

Algebra	8-10 A. M.
Plane Geometry	8-10 A. M.
English	10-12 A. M.
Latin, first year	1-3 P. M.
Latin, second year	1-3 P. M.
German, first year	1-3 P. M.
German, second year	1-3 P. M.
Botany	3-5 P. M.

Friday:

Algebra	8-10 A. M.
Solid Geometry	8-10 A. M.
History, General	10-12 A. M.
History, American	10-12 A. M.
History, English	10-12 A. M.
Civics	1-3 P. M.
Physiology	1-3 P. M.
Physiography	1-3 P. M.
Physics	3-5 P. M.
Latin, first year	3-5 P. M.
Latin, second year	3-5 P. M.
German, first year	3-5 P. M.
German, second year	3-5 P. M.

The Registrar will arrange for the other entrance examinations required by the candidates for admission.

GENERAL STATEMENT CONCERNING ENTRANCE UNITS

Students and others desirous of learning something of the amount and kind of work required for entrance to Freshman classes will find suggestive outlines below for some of the most important subjects.

Foreign Languages

The work in foreign language should be a careful preparation which shall enable the student to continue the same work in college with ease. Whether the amount of reading covered is relatively small or great, the training should consist of a thorough knowledge of grammar. Proficiency is of the greatest importance.

Suitable texts may be found in the Report of the Committee of Twelve of the Modern Language Associations of America. A representative amount of work in preparation is as follows:

1. LATIN. Four units accepted.

First year: Thorough work with an acceptable elementary text, mastery of forms, readiness in writing simple Latin.

Second year: Four books of Caesar or the equivalent; Latin prose, one period each week.

Third year: Six orations of Cicero; Latin prose, one period each week.

Fourth year: Six books of Virgil; prose or mythology, one period each week.

2. GERMAN. Four units accepted, but three units outlined.

First year: Careful drill upon pronunciation from trained teacher, not from books; rudiments of grammar, conversation and colloquial German; reading of from 60 to 100 pages of graduated texts, with constant practice in translating into German easy variations upon sentences selected from the reading lesson.

Second year: Reading from 150 to 200 pages of easy stories and plays, accompanying practice, as in first year, in the translation into German of easy variations, continued drill in rudiments of grammar and conversational use of knowledge.

Third year: Reading of about 300 pages of moderately difficult texts, with constant practice in giving German paraphrases and abstracts of the matter read, grammatical drill with special reference to auxiliaries, tenses, moods, and some attention to word formation.

3. FRENCH. Four units accepted, but three units outlined.

First year: A full statement of the work to be done and suggestions as to methods and texts may be found in Section X-XII of the Report of the Committee of Twelve of the Modern Language Association of America. The work should comprise the elements of the grammar, with exercises and drill in easy conversation, especially pronunciation. The reading should consist of from 150 to 200 pages of easy texts,

Second year: Reading of from 250 to 400 pages of texts. Review of the principles of grammar, with exercises and composition. Conversation practice based on texts and grammar.

Third year: Reading of from 400 to 600 pages of texts. Free composition. Summaries of texts and conversation drill. Study of a grammar of moderate completeness.

4. GREEK. Four units accepted, but two units outlined.

First year: The elements of Greek grammar and the reading of easy selections; in the latter part of the year the reading of a portion of Xenophon's Anabasis or of some other Attic prose of the same grade. The regular paradigms should be thoroughly mastered and a considerable vocabulary acquired.

Second year: The reading of the remainder of the first four books of the Anabasis or portions of Cyropaedia; in the second half of the year the reading of some other piece of Attic prose, such as Xenophon's Hellenica or the orations of Lysias, or of three or four books of Homer.

While accurate knowledge of the grammar of the language is essential for real progress, and slipshod work is to be avoided, it should be remembered always that this is but a means to an end — the inspiration and culture that comes from the Greek spirit.

5. SCANDINAVIAN. Four units accepted; two units defined.

In this group Norse, Swedish and Danish are accepted. Only one of them, Norwegian, is defined. The same suggestions given for Norwegian may be applied to the Swedish or the Danish.

First Year: The work of the first year should aim to give the student (1) an accurate pronounciation; (2) a knowledge of the rudiments of the grammar; (3) the ability to translate simple sentences into Norwegian and to express in idiomatic Norwegian simple ideas; (4) the ability to understand simple ideas expressed orally in Norwegian; (5) a vocabulary and knowledge of construction sufficient to enable him to read ordinary Norwegian with considerable ease.

The drill in pronunciation should begin with the first meeting of the class and should continue unremittingly until the last. It is not only an end in itself, but it makes for accuracy in the knowledge of grammatical forms and is a great aid in the retention of the vocabulary. As a part of such drill frequent dictations are indispensable.

The grammatical work should include the regular and the more common irregular verbs, the inflection of nouns, adjectives, participles, and pronouns, the use of pronouns, adverbs, prepositions and conjunctions, sentence-order, and the elements of syntax. In addition to the grammar a minimum of about a hundred fifty pages of easy material should be read.

Second Year: The work of the second year should include the reading of a minimum of three hundred fifty pages of modern prose, including a number of short dramatic works, with constant practice as before in translation of the variations of the text read. The drill in pronunciation

and the writing of Scandinavian from dictations should be continued. The grammar work should include a careful review of the ground covered in the first year, with drill upon all irregular verbs that are not very rare, the uses of the subjunctive, and a more detailed study of the syntax. There should be constant practice in the construction of sentences. Students should be required to give either orally or in writing abstracts of portions of the texts read.

English

The three units required in English include the following subjects, and should provide the training indicated below:

1. ENGLISH AND AMERICAN LITERATURE, 1½ units.

The following books, recommended by the Joint Conference on Uniform Entrance Requirements in English, have been accepted by practically all the colleges in the United States, and are the basis for the requirements in literature for admission to this college.

COLLEGE ENTRANCE REQUIREMENTS IN ENGLISH FOR 1915-1919

A. READING

With a view to large freedom of choice, the books provided for reading are arranged in the following groups, from each of which at least two selections [1] are to be made, except as otherwise provided under Group I.

I. CLASSICS IN TRANSLATION. The Old Testament, comprising at least the chief narrative episodes in *Genesis, Exodus, Joshua, Judges, Samuel, Kings*, and *Daniel*, together with the books of *Ruth* and *Esther*. *The Odyssey*, with the omission, if desired, of Books I, II, III, IV, V, XV, XVI, XVII. *The Iliad*, with the omission, if desired, of Books XI, XIII, XIV, XV, XVII, XXI. *The Aeneid*. (*The Odyssey, Iliad*, and *Aeneid* should be read in English translations of recognized literary excellence.)

For any selection from the above group a selection from any other group may be substituted.

II. SHAKESPEARE. *Midsummer Night's Dream. Merchant of Venice. As You Like It. Twelfth Night. The Tempest. Romeo and Juliet. King John. Richard II. Richard III. Henry V. Coriolanus. Julius Caesar.*[2] *Macbeth.*[2] *Hamlet.*[2]

III. PROSE FICTION. Malory: *Morte d'Arthur* (about 100 pages). Bunyan: *Pilgrim's Progress*, Part I. Swift: *Gulliver's Travels* (voyages to Lilliput and to Brobdingnag). Defoe: *Robinson Crusoe*, Part I. Goldsmith: *Vicar of Wakefield*. Frances Burney: *Evelina*. Scott's novels: any *one*. Jane Austen's novels: any *one*. Maria Edgeworth: *Castle Rackrent* or *The Absentee*. Dickens's novels: any *one*. Thackeray's novels: any *one*. George Eliot's novels: any *one*. Mrs. Gaskell: *Cranford*. Kingsley: *Westward Ho!* or *Hereward, the Wake*. Reade: *The Cloister and the Hearth*. Blackmore: *Lorna Doone*. Hughes: *Tom Brown's School Days*. Stevenson: *Treasure Island, Kidnapped*, or *Master of Ballantrae*. Cooper's novels: any *one*. Poe: Selected *Tales*. Hawthorne: *The House of Seven Gables, Twice Told Tales*, or *Mosses from an Old Manse*. A collection of Short Stories by various standard writers.

IV. ESSAYS, BIOGRAPHY, etc. Addison and Steele: *The Sir Roger de Coverley Papers* or Selections from *The Tatler* and *The Spectator* (about 200 pages). Boswell: Selections from the *Life of Johnson* (about 200 pages). Franklin: *Autobiography*. Irving: Selections from the *Sketch Book* (about 200 pages), or *Life of Goldsmith*. Southey: *Life of Nelson*. Lamb: Selections from the *Essays of Elia* (about 100 pages). Lockhart: Selections from the *Life of Scott* (about 200 pages). Thackeray: Lectures on Swift, Addison, and Steele in *The English Humourists*. Macaulay: any *one* of the following essays: *Lord Clive; Warren Hastings; Milton; Addison; Goldsmith; Frederick the Great; Madame d'Arblay*. Trevelyan: Selections from the *Life of Macaulay* (about 200 pages). Ruskin: *Sesame and Lilies* or Selections (about 150 pages). Dana: *Two Years before the Mast*. Lincoln: Selections, including at least the two Inaugurals, the Speeches in Independence Hall and at Gettysburg, the Last Public Address, the Letter to Horace Greeley, together with a brief memoir or estimate of Lincoln. Parkman: *The Oregon Trail*. Thoreau: *Walden*. Lowell: Selected Essays (about 150 pages). Holmes: *The Autocrat of the Breakfast Table*. Stevenson: *An Inland Voyage* and *Travels with a Donkey*. Huxley: *Autobiography* and selections from *Lay Sermons*, including the addresses on *Improving Natural*

[1] Each selection is set off by periods.
[2] If not chosen for study.

Knowledge, A Liberal Education, and *A Piece of Chalk*. A collection of Essays by Bacon, Lamb, De Quincey, Hazlitt, Emerson, and later writers. A collection of letters by various standard writers.

V. POETRY. Palgrave: *Golden Treasury* (First Series), Books II and III, with special attention to Dryden, Collins, Gray, Cowper, and Burns. *Golden Treasury* (First Series), Book IV, with special attention to Wordsworth, Keats, and Shelley (if not chosen for study under B). Goldsmith: *The Traveller* and *The Deserted Village*. Pope: *The Rape of the Lock*. A Collection of English and Scottish ballads; as, for example, some Robin Hood ballads, *The Battle of Otterburn, King Estmere, Young Beichan, Bewick and Grahame, Sir Patrick Spens*, and a selection from later ballads. Coleridge: *The Ancient Mariner, Christabel*, and *Kubla Kahn*. Byron: *Childe Harold*, Canto III or IV, and *The Prisoner of Chillon*. Scott: *The Lady of the Lake* or *Marmion*. Macaulay: *The Lays of Ancient Rome, The Battle of Naseby, The Armada*, and *Ivry*. Tennyson: *The Princess* or *Gareth and Lynette, Lancelot and Elaine*, and *The Passing of Arthur*. Browning: *Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, Hervé Riel, Pheidippides, My Last Duchess, Up at a Villa—Down in the City, The Italian in England, The Patriot, The Pied Piper, "De Gustibus—,"* and *Instans Tyrannus*. Arnold: *Sohrab and Rustum* and *The Forsaken Merman*. Selections from American poetry, with special attention to Poe, Lowell, Longfellow, and Whittier.

B. STUDY

One selection to be made from each group.

I. DRAMA. *Julius Caesar. Macbeth. Hamlet.*

II. POETRY. Milton: *L'Allegro, Il Penseroso*, and either *Comus* or *Lycidas*. Tennyson: *The Coming of Arthur, The Holy Grail*, and *The Passing of Arthur*. The selections from Wordsworth, Keats, and Shelley in Book IV of Palgrave's *Golden Treasury* (First Series).

III. ORATORY. Burke: *Speech on Conciliation with America*. Macaulay's *Speech on Copyright* and Lincoln's *Speech at Cooper Union*. Washington's *Farewell Address* and Webster's *First Bunker Hill Oration*.

IV. ESSAYS. Carlyle: *Essay on Burns*, with a selection from Burns's Poems. Macaulay: *Life of Johnson*. Emerson: *Essay on Manners*.

In the study of the books prescribed above, the constant aim should be to develop the student's power of appreciation. He should be trained to observe for himself, to analyze for himself, to reach judgments of his own. One excellent method is to give with each assignment specific questions directing attention to certain qualities of thought or plan or style. The selecting of appropriate epithets and figures of speech, of beautiful, suggestive, or forcible phrases, of qualities that make style now easy or familiar, now ornate, dignified, or forcible, will develop a sense of literary values, and cultivate the power of literary appreciation. Moreover, by such study the student will insensibly strengthen and enrich his power of self-expression. Having been trained to see and to appreciate clearness, force, and beauty, he should strive to develop these qualities in his own writing, and should thereby come to feel the utility of literature as well as its beauty. The teacher who appreciates that in this development is the end to be sought, will guard against giving ready-made judgments which may injure by forestalling investigation. Properly taught, literature calls for observation, analysis, comparison, as truly and as constantly as does botany. The teacher's function is largely to direct this observation. Manuals of literature, however excellent, should be treated as subsidiary. Biographical details may be helpful in stimulating interest, the conditions of the time may supply the setting, but the thing to be *studied* is the book itself.

2. COMPOSITION AND RHETORIC AND GRAMMAR, 1½ units.

In composition and rhetoric the constant aim should be to acquire the habit of clear, correct, and forceful expression. To secure this result the

fundamental principles of rhetoric should be taught, not as an end, but as a means to an end—the development of skill; not as definitions to be memorized, but as methods conducive to better self-expression. Accordingly the course should require constant practice in writing, followed by careful revision and correction. The topics for themes may be drawn in part from other studies, such as literature and history, but in the main they should rest upon experience and observation, in order that the student may be trained to plan and to express his own thoughts. In all his writings he should cultivate habits of correct spelling, sentence-structure, punctuation, and paragraphing. Should his first themes prove defective in these respects, the College reserves the right to require him to make up his deficiencies.

In grammar there should be a thorough review occupying the semester, or at least half time for one semester, preferably in the last year of the high school course. Earlier in the course the student is not mature enough to master the more difficult relations of the sentence, or to appreciate how necessary a clear knowledge of sentence structure is to real progress in composition. If the student does not understand the structure of the sentence, he cannot reasonably be expected to frame sentences that are correct in structure or to learn to construct better sentences; thus his ignorance of grammatical relations may impede his progress in composition.

The percentage of failures in the first course in college composition would be materially reduced if grammar were more thoroughly reviewed in the last year of the high school course. From this review the student should be helped in the following ways:

a. He should be trained to analyze good modern prose, sentence by sentence, from such authors as Addison, Macaulay, Hawthorne, and Stevenson. He should be trained to observe clearness, emphasis, unity, climax, variety, and other qualities in sentence structure, and to note the effect of different types of sentence—short, long, balanced, loose, and periodic.

b. He should be trained to construct sentences of all types. One very helpful method is for the teacher to give out in analyzed form well-constructed sentences of the various types, and require the student to arrange these elements in the best order for clearness, emphasis, balance, climax, etc. Most students find this constructive work more interesting than the analytical, and also more helpful.

c. He should be trained to analyze the sentences of his own essays, to note sameness or variety in sentence length and form, also clearness, emphasis, balance, and other qualities essential to effective expression. It is not assumed that his high school course in English will make him a master sentence-builder, but it should give him sufficient knowledge and practice to make his every sentence clear and correct, and it should start him on the road to mastery.

3. Elective Units in English.

Students who present the required units set forth above, may also receive one elective unit for additional work. This unit will be granted

for additional composition, for more extended study of English or American classics, or for the study of a good history of literature, supplemented by study of some of the minor authors not previously studied, or by more minute or more extended study of the major authors.

History

It is recommended that four years of history be given in the high schools, as proposed by the Committee of Five in its report to the American Historical Association. This plan may be stated as follows:

One year of Ancient History to 800 A. D.; one year of English History, beginning with a brief statement of England's connection with the ancient world, and tracing the main line of English development to about 1760, including as far as possible the chief facts of general European history, especially before the seventeenth century, and giving something of the Colonial history of America; one year of Modern European history, including such introductory matter concerning later medieval institutions and the beginnings of the modern age as may be deemed wise or desirable, and giving a suitable treatment of English history from 1760; and one year of American history and government, arranged on such a basis that some time may be secured for the separate study of government.

If only three years be given over to history, it is recommended that one year be given to Ancient and Medieval history; one year to Modern European history, including Colonial America; and one year to American history and government.

It is urged that considerable attention be given to economic history in all of the courses offered. The best modern text books should be used, and there should also be outside reading, with notes and some instruction in historical geography.

If economics is offered, it should be given as a separate course in the senior year.

Mathematics

1. Algebra, 1½ to 2 units.

One and one-half units, representing at least one and a half years of work with daily recitations, are required. The work should include fundamental operations, factoring, fractions, simple and quadratic equations, graphic work, theory of exponents, ratio and proportion. This may be given in succeeding semesters, or, following the recommendations of the Central Association of Mathematics and Science Teachers, the first year, including, if possible, simple quadratics, may be followed by a year of plane geometry, after which the third semester of algebra may be taken. Many schools have adopted this order with highly gratifying results. In any case, thoroughness is necessary. The third semester, besides covering quadratic equations, should include a review of the more important phases of the entire subject. In addition to the three semesters of algebra required for admission, credit will be given for a fourth semester if the work is distinctly in advance of that which should be accomplished in the

year and half usually allotted to this subject. The work must be done in the fourth year and must include a careful review of at least the third semester's work and the following additional topics: variations, arithmetical and geometrical progressions, binomial theorem for positive and integral exponents, and such other topics as time and the advancement of the class will permit.

2. Plane Geometry, 1 unit.

An entire year should be devoted to plane geometry, with much attention to problems. The skilled teacher will constantly apply in a concrete way the principles learned and will lose no opportunity to review the algebra of the preceding year. (See "Geometric Exercises for Algebraic Solution," The University of Chicago Press.)

3. Solid Geometry, ½ unit.

Required for entrance to all engineering courses. Should be taken in high school. One half year should be devoted to it. Elective entrance credit for all other courses.

4. Trigonometry, ½ unit.

This subject is not ordinarily taught in high schools, nor should it be encouraged except in the larger city schools. Only plane trigonometry should be given. A half-year should be devoted to it, and the work should include the definitions and relations of the six trigonometrical functions as ratios, the theory of logarithms and use of tables, the proof of important formulae, and considerable practice in trigonometric transformations and the solution of the right and oblique triangles.

Science

Four and one-half units will be accepted in this division for entrance credit.

No more work in this group should be undertaken than can be treated satisfactorily by laboratory methods. It is recommended that, in general, subjects offered be pursued for at least a year.

There should be running water and adequate drainage in all rooms used for laboratory purposes and sufficient apparatus to enable the student to demonstrate or investigate at first hand the phenomena or topics under consideration. In all science work, good light, abundant table space, and dust-proof cases for apparatus are absolutely necessary.

1. Agriculture, ½ to 2 units.

The development of the study of agriculture in high schools in Iowa is now such that it merits a recognition in entrance requirements. Where the high school does work of the proper quality and sufficient in quantity to cover one-half or more units, entrance credit will be given as above indicated.

Credit in plant industry will be given for approved work in horticulture, farm crops, forestry, and soils. This will include the study of plant propagation, plant nutrition, and plant improvement, and such various

sub-topics as may be correctly included under horticulture, farm crops, forestry, and soils and their relations to plant production.

Animal industry will include the subject of breeds of farm animals, animal nutrition, animal feeding, care, and improvement. It will include the study of poultry and dairying as special topics, with such attention to bees, birds, and insects as belongs under the topic of Animal Industry as related to agricultural interests.

General agriculture will include the study of topics under farm management, farm engineering, rural economics, rural sociology, and rural organization; also such units in animal and plant industry as may be included.

Rural economics will include history of agriculture in the United States; crop and stock relationship; markets; rural organizations, such as rural church, rural school, and rural club; land tenure; farm labor; farm records; and rural community problems as related to the economic and social conditions of rural life.

2. Astronomy, ½ unit.

3. Botany, ½ to 1 unit.

The aim in the study of botany in the high school course should be to make the pupils familiar with the local flora. Outdoor work is to be emphasized, especially in its economic aspects. Students cannot be too familiar with the ordinary facts of their surroundings; and the habit of accurately observing and then carefully recording what is discoverable in the outdoor world should be established from the outset. A carefully kept notebook, containing notes of all sorts concerning plants studied, their characteristics, conditions of growth and dispersal, time of flowering and fruiting, is essential in all natural history work. A herbarium prepared by the student is generally impracticable and is not recommended. The economic phases of botanical science should be particularly heeded and the attention of the student, especially in our more rural communities, should be constantly directed to the relations of plants to each other, whether for advantage or the reverse.

The high school should offer laboratory work along with Leavitt's Lessons, or Bergen & Davis' "Principles of Botany," or Coulter's "Text-Book of Botany," or any other work covering the same general ground.

The minimum amount of work for preparatory credit is the equivalent of five recitations or exercises a week for one-half the year. If the teacher is well prepared and opportunity offers, the work may extend through the entire year. Ordinarily work in botany should come in the first or second year in the high school course.

4. Chemistry, 1 unit.

This is a profitable secondary school study if properly taught, but it should not be offered unless laboratory facilities are adequate. As in physics, double laboratory periods are essential to good work.

Chemistry should come in the last year of the high school, or the last but one. An entire year should be devoted to the subject; no entrance

credit will be given for less than a one year course, done with effective, individual laboratory work.

5. GENERAL SCIENCE, ½ to 1 unit.

The General Science offered in the first or second year of the high school has a double purpose: first, to meet the needs of those who drop out of school after the first year and therefore receive no further training in science; second, to serve as an introductory and preparatory course for those who will take more advanced study in science. Science for the first year should not be too technical or go too much into detail. The teacher at the same time should avoid giving a smattering of physics, physiography, botany, etc. The natural phenomena with which everyone is familiar should be explained scientifically Physics, chemistry, biology, hygiene, physiography, as applied to every day experiences should be taught.

6. GEOLOGY, ½ unit.

7. PHYSICAL GEOGRAPHY, ½ to 1 unit.

A half year should be devoted to the subject, and in exceptional cases, in the midst of rich geological areas, a year may be given In any case there should be much field work, with such use of the laboratory as the skill of the teacher and material available will warrant. The subject should come in the early part of the course, usually the first semester.

8. PHYSICS, 1 unit.

One year should be given to this subject, at least two double periods each week being devoted to the laboratory. In the laboratory students should work singly, or in small groups. Each student should perform at least thirty individual experiments, about twenty being quantitative, each illustrating an important physical principle.

While the whole field of physics should be covered during the course, less emphasis should be placed upon the amount of data and disconnected facts than upon the explanation of every-day physical phenomena and thorough drill in fundamental principles.

Physics should come in the last year of the high school course, or in the last but one.

9. PHYSIOLOGY, ½ unit.

No one should attempt to teach a subject so vitally related to the welfare of the community unless he has had special preparation in the laboratories of a higher institution. A teacher properly trained is the prime essential for the successful teaching of physiology.

A trained teacher will give due place to the laboratory work of a course in physiology, largely through demonstrations and simple experiments. The compound miscroscope should be used occasionally, but macroscopic studies are more important. A large place in the course should be left for such practical topics as diet, sanitation, and personal hygiene.

The work in physiology may well form the second semester of a year's course in biology, the first semester being devoted to zoology.

10. ZOOLOGY, ½ to 1 unit.

A good text is desirable, but it should serve simply to give definiteness and stability to the course. The chief work must be done in the laboratory. Expensive equipment is not necessary, but there should be abundant table room for each pupil, note-books, and a few cheap tools.

It is recommended that a few typical animal groups be made the subject of study, that acquisition of correct habits of observation and definite knowledge of a few animal forms be sought, and that little attention be given to the learning of classifications and to a superficial text-book knowledge of the animal kingdom as a whole.

The work should extend over at least one semester, and may be followed most profitably by a semester in which emphasis is given to human physiology. But if one semester is devoted to zoology, a second semester should be given to physiology or botany, the two forming a coherent course in biological science.

Commercial Subjects

In this group are two subjects, arithmetic and bookkeeping, which have long been recognized as suitable electives for college entrance. The other subjects are not yet well organized, except in the larger schools, and when presented in the smaller schools are often taught by those not specially fitted for this semi-technical work. It has been provided, therefore, that the Inspector shall, in June of each year, provide each of the three institutions with a revised special list of accredited schools whose certificates in the commercial branches, in the industrial branches of Group 7 (see page 30), and in Agriculture may be accepted.

The commercial subjects as defined in the proceedings of the North Central Association of Colleges and Secondary Schools are listed on page 29.

Manual Training, or Industrial Subjects

The limitations already noted in reference to commercial subjects are necessarily laid upon this group also. The minimum time given to the study each year, in order to count as one unit credit, should not be less than the equivalent of 360 periods of 45 minutes each. For most of this work double class periods are particularly desirable; for some of it they are absolutely necessary, if satisfactory results are to be obtained. Space will not permit the outlining of the subjects in this group, but again reference is made to the satisfactory outlines worked out by a representative committee of the North Central Association.

Under the division of industrial subjects there are three important lines of work. (See page 30).

Miscellaneous Subjects

PUBLIC SPEAKING, ½ unit.

This subject is a part of the English Group and when offered must be in addition to the three years of required work in English.

The course should consist of (1) the fundamentals of Public Speaking — voice building and expression; (2) interpretation — vocal interpretation,

criticism, and delivery; (3) interpretative analysis — character study, dramatic and analytical interpretation; (4) practice in preparing and presenting dramatic productions, orations, and speeches for special occasions; (5) extempore speaking and debate.

BIBLE STUDY, ½ to 1 unit.

This course may consist of a half year's work in either Old Testament History, Old Testament Narrative, or New Testament History.

The courses must be pursued under the same conditions as credit work in the regular courses in history and English.

MUSIC, ½ to 2 units.

(1) Chorus singing and rudiments, ½ unit. (2) Harmony, 1 unit. (3) Musical appreciation, ½ unit.

The credit given should have the same time consideration as that for other subjects.

AGRICULTURE, 2 units in addition to the two units defined in Group V.

The tendency in Iowa high schools is to increase the amount of work offered in Agriculture.

PSYCHOLOGY, ½ unit.

This should be a general course dealing in an introductory way with the physiological conditions of mental life, the forms and laws of conscious experience, the nature of mental development, and the applications of psychological principles to practical problems.

Advanced Standing

Students of other colleges will be admitted to advanced standing in this college under the following conditions:

First, they must present a letter of honorable dismissal.

Second, the entrance requirements to this college must be fully satisfied (see Admission from Other Colleges under Entrance Requirements).

Third, it is required that all credits from other colleges be sent by the proper officers of such institutions, duly certified, to the Registrar of this College; such certificates to include number of weeks the student has pursued the studies in question and the number of hours' credit received in each semester, as well as the portion of the subject covered.

No standing shall be accepted from any high school or academy for regular four year college work. It is, however, the privilege of any student to ask for and receive examination in any subject taught in any department of the College, provided that he can show to the satisfaction of the head of the department that he has made the necessary preparation for it.

Students in other colleges who desire advanced standing are divided into four classes:

A. College graduates who desire baccalaureate degrees.

A graduate of any college of approved standing may be granted the degree Bachelor of Science in any course offered by the divisions of Agriculture, Industrial Science, Engineering, or Home Economics, upon the

completion of 72 credits in residence, or, in special cases, upon the completion of such number of credits as may be fixed by the committee on advanced standing.

In all cases the student shall take all the required technical subjects taught by the department in which he is classified and such other technical and non-technical subjects as shall be specified by the head of the department and the dean of the Division to a total of 72. This does not abrogate the rule that all specified prerequisites or their equivalents shall be met as determined by the committee on advanced standing. Such students are registered and classified in the Senior College.

B. Students of colleges with which Iowa State College has coöperative agreements.

Approved colleges and universities may enter into a coöperative agreement with Iowa State College whereby the students may graduate from both institutions upon completion of five years of work.

This agreement requires the student to complete at least three years of work, securing thereby at least ninety credits — including certain specified credits — from such institutions.

The student may then enter the College as a Junior student in the divisions of Agriculture, Industrial Science, Engineering, or Home Economics, and graduate from the various courses offered by these divisions in two years upon the completion of 72 credits, or in special cases upon the completion of such greater or less number as the committee on advanced credits shall recommend.

1. Students shall in all cases present at least 90 credits (40 of which shall be in science).

2. Two years shall be spent in residence at the College and at least 72 credits shall be completed here.

3. In all cases the student shall take all the technical subjects required by the major work in which he is classified, and such additional technical and general work as may be required in the course elected, but the maximum requirement will not usually exceed 72 credits. Such student will, upon entering this College, be admitted to senior college classification.

4. Information relative to the specific credits in Science, which must be included in the ninety presented, as well as list of institutions with which such coöperative agreements have been made, may be secured from the Registrar.

C. Students of the Iowa State Teachers' College desiring to take one semester or one year of work at the College for credits toward a degree in the former Institution.

An agreement has been entered into by the faculties of the Iowa State Teachers' College and the Iowa State College whereby students of either institution may pursue certain subjects in the other and receive credit therefor toward graduation.

Four divisions of the College — Agriculture, Engineering, Industrial

Science, and Home Economics — are open to students of the Iowa State Teachers' College under this arrangement.

Any student who has completed two years of college work at the Iowa State Teachers' College may take one semester or one year of work in the College and receive credit therefor toward graduation at the former institution, subject to the following regulations:

1. All of the work taken shall consist of technical subjects from a single division of this College, or the prerequisites for such subjects.

2. For classification in college work in the Division of Agriculture or Home Economics, credits in the following subjects must be presented: Chemistry, 1, 2, and 3; physics, 1 and 2; zoology, 1 and 2; botany, 1 and 2.

For classification in the Division of Industrial Science, at least 20 credits in Science must be presented.

For classification in the Division of Engineering, credits in the following must be presented: Chemistry, 1, 2, and 3; physics, 1, 2, and 3; mathematics, 1, 2, 3, 4, and 5.

3. The student shall register as a special junior under the dean of the division concerned.

4. Students in normal (non-collegiate) classes in the Iowa State Teachers' College who cannot fulfill the college entrance requirements for college work at the Iowa State College, may take subjects offered in the two year non-collegiate courses at the College.

5. The prerequisites, or their equivalents, for the technical courses as given in the catalogue shall be met in all cases.

6. The course of study in each instance shall be made up from the subjects specified by the various divisional faculties as best meeting the needs of the students from the Iowa State Teachers' College. In any case where the student's best interest may be served thereby, the deans of the respective divisions are authorized to make alterations. Information relative to specified subjects may be secured from the registrar.

D. Students from other colleges.

Work of recognized merit that has been taken in colleges and universities of good rank and standing will be credited for an equivalent amount of work so far as it applies in any course offered in this College.

Students taking work in this way will present official records of their work to the advanced standing committee at the office of the Registrar to ascertain the credits to be allowed on it. It will be understood between the applicant and the committee that the credits are only provisionally accepted and that their final acceptance depends wholly upon the student's maintaining a good average standing for one year at the College.

GRADUATE WORK IN EDUCATION AT THE STATE UNIVERSITY

After one year of study graduates of the State College should be able to meet the requirements to receive the degree of Master of Arts from the State University of Iowa and receive the Masters' diploma of the College of Education of that university.

Special Students

Students taking special work in any of the College courses must be at least twenty-one years of age, must give good and satisfactory reasons for desiring such classification, and must furnish satisfactory evidence that they are thoroughly prepared to pursue the work chosen. Permission to take such special course and the subjects included therein depends upon the approval of the President of the college and the Dean or Head of the Department in which the student seeks enrollment.

Permission to take a special course will not be granted to students until they have completed the Freshman year of some one of the courses offered, and then only for a period not to exceed two years. Exceptions to the regulations requiring the completion of the Freshman year, and to the rule limiting the special course to two years, will be made in case of persons of mature years who desire to take a particular line of scientific or technical work, and whose application to take such course is approved by the Faculty of the Division in which the student seeks enrollment, and by the President of the College.

Special students are subject to the same rules governing conditions on back work as apply to all other students. The standard prerequisites for advanced work are subject to limited modification with the approval of the Dean of the Division in which the student is classified. A student wishing to change from a regular to a special or irregular course, either in the same or another department, will not be permitted to change from one course to another if he has a "condition" or a "not pass" in a subject not common to the two courses; or if he has more than one "condition" or "not pass" in subjects common to the two courses. Special students, as well as regular students, are subject to the conditions given under Requirements for Admission.

It is the theory of special classification that students should be particularly strong and well prepared to do thorough work in the studies they elect. A high standard of scholarship will, therefore, be required of all who are thus classified.

Graduates of approved colleges, who are not candidates for a degree, may take special work in this institution under the rules governing special students, without having to complete the Freshman year in any of the college courses. Permission to take such special course and the subjects included therein depends upon the approval of the President of the College and the Dean or Head of the Department in which the student seeks enrollment.

Irregular College Students

Worthy students in good standing over twenty-one years of age, not prepared to meet the entrance requirements of the Freshman year, may be admitted without examination as irregular college students, and may pursue college work not to exceed two years, provided:

1. That they give evidence of satisfactory preparation to carry such work successfully.
2. That they show good and sufficient reasons for not taking a regular course.
3. That they present a certificate covering their entire preliminary education.
4. That they be required to obtain written permission from the President of this College to register as an irregular student.

Such students will then be registered, classified, and dealt with the same as regular College students.

Fees and Expenses

The entire expenses of a student need not exceed $400.00 per year at the College.

Honor Scholarships: The State Board of Education has provided one honor scholarship for each accredited high school in the state. This scholarship represents the same value in cash whether presented at the State College or at any one of the other state institutions. It is worth $20.00 for the year, and at the State College this amount will be allowed on fees.

As soon as any school has made its nomination for the scholarship, the school authorities are expected to report the name and address of the nominee, together with a signed certificate of scholarship, to the State Inspector of Secondary Schools, State Board of Education, Des Moines, Iowa, who will approve the nomination if the conditions have been met, forward the proper credentials to the candidate, and send the certificate of credits to the institution elected.

Nominations should be made in June, and must be made not later than August 1st of each year.

Tuition: The Code of Iowa reads as follows: "The tuition in the College herein established shall be forever free to pupils from the state over sixteen years of age, who have been residents of this state six months previous to their admission."

To non-resident students a tuition fee of $25.00 per semester is charged.

Tuition Scholarships: The form of Tuition Scholarships is intended only for those students from states other than Iowa, who, without such aid, cannot secure a college education. The conditions on which this aid is granted are as follows: (1) The applicant must be in need of financial assistance; (2) the applicant must be of good moral character; (3) the applicant must give evidence of good preparation; (4) the recipient must give evidence of ability by good standing in one of the regular courses leading to the bachelor's degree.

The aid which is given from the Tuition Scholarships Fund is not regarded as a loan. If, however, a student who receives this aid is able to

return the amount in later years, it will be credited to his accounts on the books of the College Treasurer, and the sum, whatever it may be, will be put into the Tuition Scholarships Fund of the College for the use of future students.

All applications for these scholarships must be made on the uniform blanks furnished by the President.

The time of filing applications with the Chairman of the Tuition Scholarships Committee, in order to secure consideration, is as follows:

First Assignment—not later than October fifteenth.

Second Assignment—not later than January fifteenth.

All freshman and other first year students will be considered only at the second assignment unless one semester's work has already been completed at the College.

Thirty-eight tuition scholarships are available: eight to each collegiate class, two to sub-collegiate students, and four to students from foreign countries.

The applicant must be considered a member of the class indicated by his classification at the Registrar's Office.

Payment of the tuition scholarship to the recipient will be made as follows: the amount of the first semester's tuition ($25.00) will be placed to the credit of the recipient with the College Treasurer when the scholarship is awarded; and the amount of the second semester's tuition ($25.00) will be placed likewise—only, however, when the recipient has completed his registration for the second semester. The payment of scholarships awarded at the second assignment may be made as stated above, but in one amount ($50.00), when the student has completed his registration for the second semester.

Renewal of tuition scholarships will be made from year to year only upon the presentation of a new blank. In no case is this aid granted for more than one year, unless the applicant is re-entered in the competition and re-awarded a scholarship.

NOTE: Prospective freshmen should carefully consider the cost of the first year. No one should think of entering college unless he has money enough in his own right or from friends to meet his expenses in large part for his freshman year. If he goes out of his freshman year in debt he is quite sure to be seriously embarrassed for the remainder of his college course. Provision should be made to meet college bills with the same business like promptness with which one expects to meet other bills.

Incidental and Janitor Fees: The regular incidental and janitor fee for the semester is $9.00 for all students who complete their classification during the regular classification period, Monday and Tuesday Beginning with the first day on which classes are held the fee for college students will be $12.00 plus $1.00 additional for each day thereafter until the classification is completed. This fee is used as follows: hospital, $2.00; students' repair fund, $1.00; incidental and janitor service, balance. For sub-collegiate fees see page 351.

Laboratory Fees: Laboratory fees at the actual cost of breakage and usage are charged to the students, the Treasurer's receipt for such fees being required before the students are admitted to laboratories. For the

amount of the fee in any study, see description of the study under its department.

Board and Room: About three hundred twenty-five young women can secure rooms in Margaret Hall and the new dormitories. Students rooming in these buildings will be furnished with bed, mattress, rug, chairs, dresser, and table. Students will furnish bedding and such other articles as they need.

The price for rent, heat, and light will be from $8.00 to $16.00 per month for the double rooms, according to the size and quality of the room. The room rent will be for the semester. Each semester's rent is payable in advance at the Treasurer's office. In case of failure to take the room after making the deposit, the student will forfeit $10.00. There are twenty single rooms. In the other rooms two persons will divide the rent. The Advisor for Women reserves the right to assign two persons to each room if necessary.

All young women rooming in dormitories on the campus are required to board at the boarding halls of their respective dormitory. All other students can secure furnished rooms and board in clubs or private families adjacent to the college grounds at $5.75 per week.

In order that undesirable rooms and houses may be avoided, all young women students are required to secure rooms through the Advisor for Women, and the young men students should consult the Secretary of the Young Men's Christian Association, Alumni Hall, Ames, Iowa. For sanitary or other reasons the college authorities reserve the right to forbid students from rooming in any particular house.

No group of young women students may establish a "house" or "home," nor make any definite plans in such direction, without the full knowledge and approval of the President and the Advisor for Women. No young woman may become a resident of a sorority house until after she has been initiated into the sorority.

For the information of students, clubs, and interested private families the Committee on Student Accommodations has prepared standard regulations to assist in the management of houses which furnish room or board to students. These regulations are for the use of members of the instructional and clerical staffs and other members of the college community when reference to standard practice is desirable. Houses accommodating both students and others who are not students are expected to observe regulations for houses accommodating students. Copies of these regulations may be secured from the President's office, the Y. M. C. A. Secretary, or the Chairman of the Committee on Student Accommodations.

Diploma Fee: A diploma fee of $5.00 is payable before graduation.

Text Books: All text books and stationery may be purchased at the College Book Store at about 20 per cent below the average retail price.

Freshman Expenses

Taking into consideration the items named under Fees and Expenses, the following is an approximate estimate of the expenses of a freshman for each of the two semesters of the college year:

	Minimum Amount	Maximum Amount
Board (18 weeks)	$72.00	$90.00
Room rent (18 weeks—basis of two in a room)	27.00	36.00
Laundry	9.00	12.50
Incidental and Janitor Fee	9.00	*12.00
Laboratory Fees	15.00	25.00
Books and Equipment	19.50	45.00
	$151.50	$220.50

For engineering students, the minimum estimate should be increased fifteen dollars, under Books and Equipment, for drawing instruments and material.

In addition to these items at the beginning of the freshman year the men students will have to purchase a military suit at $14.50 (subject to market changes) and a gymnasium suit for $3.95; and the women students, a gymnasium suit for $7.00. The students are also advised to purchase a students' activity ticket and to pay class dues, which items would amount to about $6.00 for the entire year.

The military and gymnasium suits and drawing equipment will be serviceable for the entire course.

If a student is a non-resident of the state $25.00 per semester should be added for tuition.

The incidental and janitor fee, laboratory fees, books and equipment, five-dollar deposit for military suit, gymnasium outfit, and some payment toward room rent and board are required to be paid in advance.

Classification and Standings

Junior and Senior College: The students are classified in Junior and Senior colleges. The Junior college is composed of all students in the Freshman and Sophomore years; the Senior college, of all students in the Junior and Senior years.

Amount of Work: The amount of work in each course is expressed in credits, a credit meaning one recitation a week, or its equivalent, throughout the semester. It is considered that a one-hour recitation or lecture will require as much time including preparation as a three-hour laboratory, and therefore is given the same credit. Any two-hour laboratory period is equivalent to two-thirds of a three-hour laboratory.

Number of Credits: No student shall be allowed to classify in more credits than are specified in the catalogue for the semester of the course taken, unless he has an exceptionally high record in his previous college work, and then only after consent is secured from the Dean of the Division and the Head of the Department concerned. The student will be allowed

* See above rule for "Incidental and Janitor Fee."

to drop such extra work only upon permission of the Dean; he will be required to drop it in case this or any other work in this schedule is being carried unsatisfactorily. A "condition" or a "not pass" secured in such extra work shall stand as a record, and shall be considered in choosing fraternity members, but shall not be held against the student for graduation.

In general, students failing in any portion of a term's work will not be allowed to take full classification for the next semester.

Classification: No student shall be admitted to any class or dropped from it, except by authority of the classifying officer.

Conflicts: Students shall not classify in conflicting studies without the approval of the classifying officer.

Standings: All the standings are based on the scale of 100. The passing grade is 75. A student receiving from 60 to 74 per cent inclusive in any course is conditioned, and allowed to make up the condition under the direction of the head of the department.

Back Studies: Students shall be classified in back studies in all cases in which such studies are taught, subject to the first rule under Number of Credits. Any exception to this rule must be for good and sufficient reason, approved by the President of the College and the Dean.

Changing Course: A student will not be permitted to change from one course to another who has a "condition" or "not pass" in a subject not common to the two courses; or if he has more than one "condition" or "not pass" in subjects common to the two courses.

Senior Year: No student shall be considered a candidate for graduation who has not at the beginning of the second semester of the Senior year completed his work to within the maximum number of hours regularly allowed in his course for that semester. If the uncompleted work is not offered in the second semester, it shall be passed and reported to the Recorder not later than April first.

Examinations in Back Work

Examinations for back work for matriculated students will be conducted at the opening of the fall semester, on the Thursday and Friday preceding classification days, as follows:

Thursday

8-10 A. M.—Farm Crops......Farm Crops lecture room, 307 Hall of Ag.
8-10 A. M.—Mining Engineering............Room 306, Engineering Hall
8-10 A. M.—Zoology.......................Room 308, Science Building
10-12 A. M.—Agricultural Education..............Room 318, Hall of Ag.
10-12 A. M.—English...................Rooms 1 and 3, Central Building
10-12 A. M.—Civil Engineering.............Room 312, Engineering Hall
10-12 A. M.—Forestry..........................Room 210, Hall of Ag.
10-12 A. M.—Veterinary..............................Veterinary Building
10-12 A. M.—Geology.......................Room 306, Engineering Hall

1- 3 P. M.—Mechanical Engineering.....Rooms 204 and 205, Engr. Hall
2- 4 P. M.—History—Psychology............Room 208, Central Building
3- 5 P. M.—Public Speaking................Room 308, Central Building
3- 5 P. M.—Electrical Engineering........Room 205, Engineering Annex

Friday

8-10 A. M.—Horticulture................Forestry room 210, Hall of Ag.
8-10 A. M.—Chemistry..................Room 198, Chemistry Building
8-10 A. M.—Mathematics...................Room 221, Central Building
8-10 A. M.—Animal Husbandry....A. H. lecture room 117, Hall of Ag.
10-12 A. M.—Economics......................Room 222, Central Building
10-12 A. M.—Dairying...........................Room 8, Dairy Building
10-12 A. M.—Botany.........................Room 312, Central Building
10-12 A. M.—Farm Management.................Room 308, Hall of Ag.
1- 3 P. M.—Civics...........................Room 102, Central Building
1- 3 P. M.—Mechanical Engineering......Rooms 204 and 205, Engr. Hall
1- 3 P. M.—Home Economics...............Home Economics Building
2- 4 P. M.—Modern Language.............Room 119, Central Building
2- 4 P. M.—Agricultural Engr......Engr. lecture room, Agr. Engr. Hall
3- 5 P. M.—Bacteriology...................Room 105, Science Building
3- 5 P. M.—Soils.....................Soils lecture room 8, Hall of Ag.
3- 5 P. M.—Physics......................Room 207, Engineering Hall

Preceding the Spring Semester, such examinations will be given on the Monday before the close of the Christmas vacation, the hours being the same as given above. Conflicts will be arranged by the departments concerned.

Graduating Thesis

All candidates for graduation in the engineering and agricultural courses except the forestry students are expected to present a satisfactory thesis.

The subjects for theses shall be selected under the direction of the professor in whose departments they are written, and shall be submitted to the Thesis committee, with signed approval of the professor, at the beginning of the semester in which the student starts his work.

It is expected that each thesis shall represent an amount of work equivalent to at least one exercise per week through the Senior year; that it shall show the result of the student's personal study or investigation and be throughout original in matter and treatment so far as the nature of the subject will permit; that it shall be prepared under the supervision of the professor in charge, the student making frequent reports of progress and having an outline of matter ready for approval by the first week of the last semester.

The complete thesis shall be submitted to the Thesis Committee on or before May 25th.

MEDALS AND PRIZES FOR THESIS

Phi Lambda Upsilon, the honorary chemical fraternity, offers to the student presenting the best baccalaureate thesis on a scientific or technical subject a Phi Lambda Upsilon gold medal.

The thesis may be written in partial fulfillment of the requirements for the degree of Bachelor of Science or Doctor of Veterinary Medicine, or it may be written by students in courses which do not require a thesis for graduation. The thesis must be by a single individual and must embrace original material. It must be submitted to the chairman of the thesis committee of the faculty one week preceding the last day for presenting thesis to the Thesis Committee. The committee which awards the medal is to be selected by Phi Lambda Upsilon.

A prize of $10.00 for the best thesis on the subject, Relation of Poisonous Plants to Live Stock Industry of Iowa, is also offered by L. H. Pammel. This prize is open to students in the Agricultural, Industrial Science, and Veterinary Divisions.

Divisions

Division of Agriculture

Dean Curtiss, Agricultural Hall, Room 124

Vice-Dean Beach, Agricultural Hall, Room 201

The Division of Agriculture is made up of all of the departments in the college devoted to the various phases of technical and practical agricultural work. The work of these departments is closely related and the purpose of all of them is to train men for better service in agriculture.

The faculty of the Division of Agriculture is made up of the members of all of the departments within the Division and representatives of the departments in other divisions whose work serves to prepare agricultural students for a better mastery of technical work in agriculture. Under this head the following departments are included: Bacteriology, Botany, Chemistry, Civil Engineering and Architectural Engineering and Rural Structures, Economic Science, Electrical Engineering and Mechanical Engineering, English, History and Psychology, Home Economics, Mathematics, Modern Language, Public Speaking, Veterinary Anatomy and Veterinary Surgery, Veterinary Physiology and Veterinary Pathology, and Zoology.

The departments in the Division of Agriculture are as follows:

Agricultural Education (page 92): Agricultural Hall.

Agricultural Engineering (page 97): Administered jointly with the Engineering Division. Agricultural Engineering Hall.

Agricultural Journalism (page 107): Agricultural Hall.

Animal Husbandry (page 112): Including Poultry and Dairy Husbandry. Agricultural Hall.

Correspondence Study—Agriculture (Collegiate Grade) (page 111): Agricultural Hall.

Dairying (page 185): Dairy Building.

Farm Crops and Soils (page 208): Agricultural Hall.

Farm Management (page 218): Agricultural Hall.

Horticulture and Forestry: Including Forestry (page 221), Pomology (page 256), Floriculture (page 258), Truck Crops (page 260), and Landscape Gardening (page 261). Agricultural Hall.

Photography (page 314): Agricultural Hall and Chemistry Building.

Agricultural Experiment Station (page 413).

Agricultural Extension (page 404): Agricultural Hall and Morrill Hall.

The Division of Agriculture offers the following courses:

(For non-collegiate courses, see pages 355 and 361.)

These courses afford the student opportunity for pursuing study along that line of agriculture which he is especially suited to follow. The farm as it is usually conducted is a unison of many branches of industry; and these courses are so arranged as to direct the student into that branch which will call forth and centralize his special ability, and at the same time will prepare him to meet successfully the peculiar difficulties of his chosen work.

In the courses in practical and scientific agriculture a field of work which is unsurpassed by any other college in the United States is open to our students. The national government endowment fund and annual appropriations for original experimentation and instruction in Agriculture and the sciences related to this industry, supplemented by liberal state aid, enable the college authorities to make the fields, barns, orchards, and gardens veritable laboratories of extensive and most practical investigation and instruction. Just recently there have been added to the equipment of the college a new chemistry building, a new horticultural laboratory covering over 20,000 square feet of space, a farm of one hundred sixty acres to be used for experimental work in farm crops, and a new science hall. There are at present in course of construction an Animal Husbandry laboratory and a dairy barn. These buildings will be modern in every respect, and will make notable additions to the live stock equipment.

The Agricultural Experiment Station is bringing to light better methods of feeding, more remunerative systems of cropping, improved strains of fruits, and other improvements which bid fair to revolutionize certain branches of Iowa agriculture. These investigations are studied by the students first hand, and through the system of student employment a num-

ber take an active part in carrying on the work of the Experiment Station. This arrangement gives to the students clear insight into scientific methods and at the same time valuable practical experience.

In addition to laboratory work at the college, students are encouraged to visit various commercial enterprises throughout the state. Farms, orchards, stock shows, and other commercial institutions that have proved themselves of particular merit are visited by students in company with specialists from the college.

The courses of study in this Division are designed to teach the sciences that underlie practical agriculture, and sufficient English, literature, mathematics, history, and other supplementary subjects to sustain both scientific and practical agriculture and to develop the agricultural student to the level of the educated in other professions

Special attention is given to improved methods in all the various operations of farming and farm building, in the use of tools and machinery, and in the management of all kinds of stock and crops. Instruction embraces not only the principles but also the practice of agriculture. The great practical value of the courses is shown by the records of those students who have completed them and who have gone back to the farm; it is also shown by those who upon graduation have taken up the work of specialists as teachers or investigators. Such men are proving themselves leaders in their various lines.

A new course in Farm Management is offered to train men to meet the growing demand for capable farm managers, county agents, and similar work. This is a five-year course, four years being spent at the college and the fifth year in practical work away from the college. There has never been a time when there was such a wide demand for graduates combining thorough scientific training with good practical experience in agriculture. Probably no other field at present offers such good opportunities for profitable employment at good salaries as are open to the men who attain high proficiency in this work.

The Division offers exceptional opportunity to graduate students in Agriculture. The strong instructional staff and extensive equipment have drawn students from twenty states during the school year 1916-17.

Teaching and Research Fellowships and Scholarships. There are about thirty teaching and research scholarships and fellowships awarded annually in the division of agriculture to graduate students. These scholarships are awarded strictly on merit and carry a stipend of $200 to $500 each. Application should be made during the second semester of the preceding year.

Tuition Scholarships. For information see page 49.

Department of Agriculture Scholarships. The State Department of Agriculture offers scholarship prizes in this institution amounting to $600. These scholarships are awarded at the Iowa State Fair, based upon boys' stock and grain judging contests. There are five scholarships, ranging from $200 to $25. The winners of the contest receive the money in monthly instalments during the year of college work, with the exception

of the $25 scholarship which applies upon the winter short-course. These scholarships offer opportunities for young men to receive substantial aid toward paying the expenses of a college education; many excellent students have come to this institution by this means.

The Clay, Robinson & Company Fellowship. Since the organization of the International Livestock Exposition, Clay, Robinson & Company of Chicago have offered $1,000 annually to be competed for by the various agricultural colleges in their livestock exhibits at the International. This institution has always won a large share of these premiums, and the funds have been used to provide for a fellowship in agriculture to aid worthy students in advanced study. These fellowships have materially aided young men to make a better and more thorough preparation for agricultural teaching and investigation and for practical work on the farm.

Zimmerman Memorial Prize. Mr. W. F. Zimmerman of Chicago, has established a permanent fund in memory of his son Herbert, an exemplary young man who accidentally lost his life while a student enrolled in the Department of Horticulture. The income of this fund, now not less than $20.00, is offered as a prize each year to the Superior Junior Horticultural Student. All Horticultural students enrolled as Juniors are eligible for the prize.

The award will be made on the basis of ability, scholarly attainment, character, and interest in affairs which are worthy the attention of students who are preparing themselves to do the best possible work as horticulturists and as citizens.

Clubs and Agricultural Organizations.

NAME	TIME OF MEETING	PLACE
Agricultural Club	1st Thurs. of mo., 7:15	Agr. Auditorium
Saddle & Sirloin Club	Alternate Thurs., 7:15	Room 117, Agr. Hall
Horticultural Club	Alternate Thurs., 7:15	Room 208, Agr. Hall
Forestry Club	Alternate Thurs., 7:15	Room 210, Agr. Hall
Agronomy Club	Alternate Thurs., 7:15	Room 7, Agr. Hall
American Society of Agronomy	2nd Tues. of month	Room 306, Agr. Hall
Curtiss Club	Alternate Thurs., 7:15	Agr. Auditorium
Dairy Club	Alternate Thurs., 7:15	Room 11, Dairy Bldg
Alpha Zeta Fraternity	1st & 3rd Tues. of mo.	Room 19, Agr. Hall
Gamma Sigma Delta Fraternity	1st & 3rd Tues. of mo.	Room 7, Agr. Hall
Agricultural Engineering-ing Society	Tuesday, 4:00 P. M.	Room 204, Agr. Engr. Bldg.
Agr. Education Club	Alternate Thurs., 7:15	Room 109, Agr. Hall
Farm Management Club	Alternate Thurs., 7:15	Room 120, Agr. Hall

Honorary Agricultural Fraternities. There are two national honorary

agricultural fraternities that have chapters at the Iowa State College, the Alpha Zeta and the Gamma Sigma Delta. Eligibility to these fraternities is based upon scholarship, and membership is limited to the upper two-fifths of the junior and senior students of all courses in the division of agriculture.

Agricultural Publications. The students in the Division of Agriculture, under the general supervision and direction of the department of Agricultural Journalism, publish a monthly journal known as "The Agriculturist." This publication has taken high rank in its class, and it affords students an opportunity to get practical training and experience in agricultural writing. In addition, considerable of the most meritorious work of advanced students in agricultural journalism is used by the agricultural press and by daily and weekly papers.

The "Ames Forester" is an annual published by the Forestry Club. The students with the assistance of the alumni working in the field have made this an attractive publication of a technical character.

Division of Engineering

Dean Marston, Engineering Hall, Room 315

Vice-Dean Beyer, Engineering Hall, Room 303

The Division of Engineering consists of all the college departments devoted mainly to technical engineering work, together with the Physics Department. These departments are organized into a Division for the purpose of coördinating their work and promoting its quality and efficiency.

The Division was first organized about 1898. A dean was first appointed, for more effective administration, in 1904.

The faculty of the Division of Engineering is made up of the members of all the departments within the Division, and of voting representatives from the outside departments which are teaching important work to engineering students, or whose students are taught important work in the Engineering Division.

The departments within the Division are as follows:

Agricultural Engineering (page 97): Administered jointly with Division of Agriculture. Agricultural Engineering Hall.

Architectural Engineering and Rural Structures (page 122): Engineering Hall.

Ceramic Engineering (page 146): Ceramics Building.

Chemical Engineering (page 151): Administered jointly with Division of Industrial Science. Chemistry Building.

Civil Engineering (page 167): Engineering Hall, Engineering Annex, Civil Engineering Laboratory, Transportation Building.

Electrical Engineering (page 194): Engineering Annex.

Mechanical Engineering (page 284): Engineering Hall, Engineering Annex, Steam and Gas Laboratory, Transportation Building, Machine Shop, Forge Shop, Foundry, Pattern Shop.

Mining Engineering and Geoolgy (pages 235 and 301): Engineering Hall, Engineering Annex.

Physics (page 320): Engineering Hall, Engineering Annex, Ceramics Building.

Engineering Experiment Station: Engineering Hall, Engineering Annex, Ceramics Building, Chemistry Building, Civil Engineering Laboratory, Steam and Gas Laboratory, Transportation Building.

Engineering Extension and Trade School: Chemistry Building; rooms in various engineering buildings.

Departments outside the Division which have voting representatives (to the number indicated) in the Engineering faculty are as follows: Agricultural Journalism (1), Agronomy (1), Chemistry (2), Economic Science (1), English (1), History and Psychology (1), Home Economics (1), Horticulture and Forestry (1), Mathematics (2), Modern Language (1), and Public Speaking (1).

The work of the Engineering Experiment Station and the Engineering Extension Department is quite different in character from that of the other departments within the Division, and is separately organized, but is closely coordinated with the regular collegiate instruction.

The Division of Engineering offers the following courses of study:

Four-Year Courses:

Agricultural Engineering...p. 99
Architectural Engineering..p. 124
Ceramics..................p. 147
Chemical Engineering......p. 153
Civil Engineering..........p. 171
Electrical Engineering......p. 196
Mechanical Engineering....p. 288
Mining Engineering........p. 303

Two-Year Course:

Rural Structure Design....p. 129

Five-Year Courses:

Agricultural Engineering...p. 101
Civil Engineering..........p. 173
Electrical Engineering......p. 198
Mechanical Engineering....p. 290
Mining Engineering........p. 305
Industrial Sci. and Engr...p. 274
Coöperative Courses with other Colleges...........p. 46

(For six-year courses, see the provision for Engineering courses for college graduates, A., page 45.)

(For Graduate courses, see page 73.)

(For Non-Collegiate courses, see page 364.)

The Civil and the Mechanical Engineering courses were established in 1869, when the college first opened its work. Electrical Engineering was added in 1891, Mining Engineering in 1894, and Agricultural Engineering in 1909.

The purpose of all the engineering courses is to afford the student opportunity to secure the thorough fundamental and technical education which is necessary for professional work of the highest grade in engineering. The education aimed at includes training of the moral, mental, and social faculties of the student, and the maintenance and improvement of his health. Many powerful college influences in addition to the regular instruction in the courses of study contribute actively to this education.

All the studies of the engineering courses, the technical as well as the fundamental and general, have great cultural value. In this modern age no person is entitled to claim the broadest culture who is not well informed on the applications of modern science. In the engineering courses effort is made to help fit the graduate to become a good business man and a good citizen, as well as a good engineer, and to help fit him to enjoy the higher satisfactions of cultured life.

The studies of the engineering courses, though of great variety, classify naturally into two groups:

First, **fundamental and general studies**, mainly in the Freshman and Sophomore years, but extending in lesser amount through the Junior and Senior years.

Second, **technical studies**, which make up about one-fourth to one-third of the courses during the Freshman and Sophomore years, and by far the greater part during the Junior and Senior years.

The **fundamental and general studies** bear the same relation to an engineering education that a foundation bears to an engineering structure; hence, they constitute perhaps the most important part, without which the technical work cannot be undertaken successfully. The engineering student must master these fundamental and general studies with great thoroughness, and should undertake them with enthusiasm. They include the following:

Mathematics. The study of mathematics continues through at least two years; mastery of mathematics is absolutely essential to a proper knowledge of engineering science and to the successful practice of the engineering art.

Chemistry and Physics. Every engineer should be thoroughly grounded in both these subjects, one or both of which apply directly in practically all his work.

English. A thorough mastery of English is essential to the engineer, whose highest work is in dealing with men. He must be able to convince men by well written business letters and engineering reports, and, if he amounts to much as an engineer, by well written articles for engineering journals and papers for engineering societies. Also he must be able to present his views orally to employers and superior officers in a clear and convincing manner. The work in English in the engineering courses is very thorough in the general principles and applications, and in addition includes special work in business English and the writing of engineering reports and papers. The student is offered opportunity to take special instruction in public speaking, and even in engineering journalism.

Economic Science is one of the required studies in the engineering courses.

Electives. Opportunity is offered in the Junior and Senior years for engineering students, especially the best students, to elect considerable work outside their required subjects, and thereby obtain a broader and better rounded education. All studies in the college are open to such students as are prepared in the prerequisites stated in the catalogue.

The **technical subjects** in the engineering courses are of too great variety to be described here, but are fully explained in the catalogue under the headings of the individual departments. A thorough course in engineering mechanics is required of all. The technical studies extend throughout the entire four years' work, and the technical work in the various lines is intended to be of the most thorough and complete and high-grade character practicable in an engineering school.

In addition to the undergraduate engineering work **graduate studies** are offered, as shown in detail on pages 73 ff.

For students who can afford the time and expense **five-year engineering courses** are offered as already tabulated above. The five-year engineering courses contain a larger amount of general work (as distinguished from technical work) than the four-year courses, and also offer opportunity for more technical work of advanced character. Students who can afford to do so are advised to take the five-year work.

Five-year courses have also been arranged **in cooperation** with the Division of Industrial Science (at Ames), and in cooperation with several outside Iowa colleges. See page 46. These coöperative five-year courses entitle the student to receive two degrees, a Science degree at the end of the first four years, and an Engineering degree at the end of the five years.

Graduates of Standard Colleges can secure an engineering degree at the Iowa State College by two years additional technical work. See page 45.

Engineering Degrees. The four-year and five-year engineering courses lead to the degrees of Bachelor of Science in Civil Engineering, Mechanical Engineering, etc. See page 62.

Each five-year coöperative course leads to two degrees: first, Bachelor of Science; second, the same technical engineering bachelor's degree as a regular four-year engineering course. See page 46.

The professional engineering degrees of Agricultural Engineer, Architectural Engineer, Ceramic Engineer, Civil Engineer, Electrical Engineer, etc., are given only for successful outside engineering practice following a standard college engineering course. See page 72.

The degree of Master of Science in Mechanical Engineering, Mining Engineering, etc., is given only for completion of a resident graduate course in engineering. See page 70.

Besides the regular studies of the engineering courses, other agencies contribute in important degree to the professional education of the engineering students:—

Technical Lectures. Throughout the Freshman year all engineering students meet for technical lectures delivered by members of the engineering faculty; these lectures constitute a general introduction to the engineering profession.

Engineering Societies. After the Freshman year general professional association and advance are promoted by the Engineering Societies, of which there are several.

American Society of Agriculural Engineers (Local Student Branch). This meets every two weeks. All Junior and Senior agricultural engineering students are members.

Crockets. This is an organization composed of Sophomore, Junior, and Senior students in the department of Architectural Engineering and Rural Structures. This society holds meetings every two weeks.

Civil Engineering Society. This meets every two weeks. All Sophomore, Junior, and Senior civil engineering students are members.

American Institute of Electrical Engineers (Local Student Branch). This Society is a branch of the great national electrical engineering society, and membership is open to Junior and Senior electrical engineers.

Engineering Society. The Engineering Society includes all the engineering students as members, and is the student organization which directs important meetings and other affairs of interest to the entire body of engineering students. Examples are the **Engineering Campfire** every fall, the Engineering Socials, and addresses of general engineering interest by prominent outside engineers.

American Institute of Mining Engineers (Local Student Branch). This society is a branch of the great national mining engineering society.

Engineering Seminars. Engineering Seminars are a feature of the advanced engineering work common to practically all courses. In several courses the work is merged in that of the engineering societies, but in Mechanical and in Electrical Engineering the Seminar meets weekly for presentation of technical papers and discussion of engineering subjects.

Tau Beta Pi. This honorary engineering society maintains a strong local chapter, to which only the highest one-fourth (in scholarship) of the Juniors and Seniors are eligible. A feature of the work of the Chapter is an annual address to the Freshman and Sophomore engineers by some prominent outside engineer.

Non-Resident Lectures. Through the various engineering societies, and by direct action of the college, the engineering students are afforded every year the opportunity of hearing a number of valuable addresses on engineering subjects by masters of the engineering profession engaged in active work outside.

The Iowa Engineer. The engineering students publish monthly during the college year an engineering journal called "The Iowa Engineer." The editors are elected by the engineering students. Articles are contributed by engineering alumni, non-resident engineering lecturers, and members of the engineering faculty, as well as by the editors and reporters. Engineering journals are becoming so numerous and important that experience on "The Iowa Engineer" staff is very valuable.

Opportunities for Engineering Graduates. While the demand for engineers has an intimate relation to general business conditions, yet our graduates have found little difficulty in securing positions which afford excellent opportunities to make good. In normal times the demand for our engineering graduates considerably exceeds the supply.

Engineering Alumni. The engineering alumni of the Iowa State College are scattered over the entire country in most responsible positions. A $20,000,000 railway terminal in Chicago, the Florida East Coast Railway, State Highway Commission work, the work of the greatest bridge companies, great water power plants, the sewerage of Havana, great mining operations, important manufacturers, electric railways, central power stations, public utilities, the valuation of the railways of the United States, are some of the lines in which they are engaged. Engineering alumni of the college are numerous in the Philippines, Cuba, Mexico, and South America, and did important work in building the Panama Canal. Most satisfactory of all, hundreds are engaged in successful and important engineering work in Iowa; these men are doing great and valuable service in developing and improving the state.

Graduate Division

President Raymond A. Pearson, Acting Dean

GENERAL STATEMENT

The Iowa State College of Agriculture and Mechanic Arts offers major and minor work for the degree of Master of Science in the following subjects with special application to the industries: agricultural education, animal husbandry, bacteriology, botany, chemistry, dairying, economics, engineering, farm crops and soils, farm management, forestry, geology, horticulture, mathematics, physics, veterinary anatomy, veterinary pathology, veterinary physiology, and zoology. Graduate instruction leading to the degree of Doctor of Philosophy is also offered in agronomy, animal husbandry, bacteriology, botany, chemistry, dairying, geology, horticulture, and zoology. Additional minor supporting work is offered in other departments to supplement graduate study along technical lines.

FACULTY

The president, the deans, the heads of the departments in which graduate instruction is authorized, and other members of the faculties who are in immediate charge of graduate instruction are members of the Graduate Faculty.

ORGANIZATION

The instruction and training of graduate students has been one of the functions of the Iowa State College since its early history. The first degree of Master of Science was conferred in 1877. In 1879 the first degree of Civil Engineer and the first degree of Master of Philosophy were conferred. In early years the department or departments in which the student was registered mapped out the applicant's course and supervised his work. Later, when the divisions of the College had been created, each division controlled its own graduate work. It was not long, however, until the number of graduate students and the diversified character of their work demanded further organization, and a Graduate Committee was appointed to supervise the work of all graduate students. This Committee was in charge until 1913 when the increase in the graduate work made it necessary to perfect still further the organization, and the Graduate Division was established. The Graduate Division is administered by the President of the College as Acting Dean and the Graduate Faculty. Under this organization the graduate work to be pursued in any case is under the Acting Dean, the head of the department, and the professor in charge of the work.

AIMS AND METHODS

This is an age of great commercial, scientific, and social interests, and these interests are demanding greater economy, specialization in science, and more humanitarianism. To meet these demands the leaders in the different lines of industry, science, and social affairs must have access to more specialized training than can be secured in four years of study. The man who would be a successful competitor as an expert in any of the different lines of agriculture, or as a skilled chemist, engineer, botanist, bacteriologist, applied economic science expert, or as a teacher or investigator in any of these subjects can by graduate training so increase his efficiency as to open up opportunities otherwise denied him. The development of scientific agriculture, engineering, manufacturing, and all the supporting sciences is dependent upon this training. A greater Iowa, economically and socially, is impossible without it. The Iowa State College has long since realized its responsibility in the further development of the many lines of research work in harmony with the industrial needs of the commonwealth.

Lectures, laboratory work, and seminar methods in which the student is in contact with his research problems are used in the development of the graduate work. The investigative work is shared by instructor and student, and the student acquires the spirit as well as the methods of productive work. To further encourage this spirit of research, provision has been made for the publication of specially meritorious work along some of the lines of investigation of which the institution has charge.

FEES AND EXPENSES

Incidental and Janitor Fee: The regular incidental and janitor fee for the semester is $12.00, but all students who classify during the classification period, Friday and Saturday before College work begins, will be charged only $9.00 a semester. Graduate scholars and fellows are required to pay a two-dollar hospital fee, a fee of one dollar for each hour's work up to seven hours, and laboratory fees in their minor only.

Laboratory Fees: Laboratory fees at the actual cost of breakage and usage are charged to students, the Treasurer's receipt for the fee being required before the students are admitted to laboratories. Some fees represent charges for mimeograph notes which are furnished at cost; usually when these notes are supplied no text book is required and the fee is in lieu of text book purchase. Deposits are required in some departments to cover the value of equipment loaned to students, and at the end of the term the amount is returned less deduction for loss and breakage. For the amount of the fee in any study the student should refer to the description of studies under the department in which the study is taught. Scholars and fellows are exempt from laboratory fees in their major work.

Diploma Fee: For the Master's, Doctor's, or Professional Degrees, $5.00. This does not include the cost of the Master's or Doctor's hood.

CLUBS AND SOCIETIES

In the interest of research and investigation along the lines of applied science and for training in the presentation of results, several clubs and societies have been organized by the instructors and students in the different departments Among these are the following:—

Graduate Club
Iowa Section of American Society of Agronomy.
Botany Seminar.
Physics Seminar.
Applied Social Science Club.
Mathematics Colloquium.
Bacteriology Seminar.
I. S. C. Branch of the American Institute of Electrical Engineers.
Chemistry Seminar.
I. S. C. Branch of the American Institute of Mining Engineers.
Civil Engineering Society.
I. S. C. Branch of the American Society of Agricultural Engineers.

HONORARY FRATERNITIES

The following is a list of the Honorary Fraternities of Iowa State College, some of which are maintaining regular programs along lines of research work:—

Phi Lambda Upsilon.
Phi Kappa Phi
Alpha Zeta.
Tau Beta Pi.
Gamma Sigma Delta.
Omicron Nu.
Delta Sigma Rho.

ADMISSION

Graduates of Iowa State College, as well as graduates of other colleges and universities of approved standing, are admitted to the Graduate Division. Before entering upon graduate work in any department, however, the applicant must present evidence that he has had the necessary prerequisite training that will enable him to pursue with profit the courses desired. It should be remembered, also, that admission to graduate work does not necessarily imply admission to candidacy for a degree.

Graduate students wishing to become candidates for the Master's or Doctor's degree will make application in writing to the Dean of the Graduate Division not later than February 1 of the year in which the degree is sought. This application should be approved and signed by the head of the department in which the major subject is offered and by all other members of the faculty under whom the student has done work in support of his candidacy. If the applicant has completed any graduate work in another institution, an authorized statement of the same should be filed with the application for candidacy for degree.

For purposes of admission to the Graduate Division an approved college or university is one which requires four years of work of collegiate grade for graduation, based upon an entrance requirement of at least fourteen standard high school units.

Candidates for admission to the Graduate Division are required to submit to the Registrar or Dean a complete authorized statement of their

college or university records, including a statement of their entrance credits. A blank application for admission which contains definite instructions regarding admission may be secured from the Registrar or Dean.

When an application has been approved, the Registrar issues a permit to enroll. Upon the payment of fees the candidate is given a receipt which he presents to the Dean, the classifying officer.

Registration should be on regular classification days to avoid payment of extra fee, and it should be completed within two weeks after the opening of a semester to receive full credit for the semester's work.

CLASSIFICATION

The classification of all *regular* graduate students must be completed in conformity with the following rules:—

1. Fifteen credit hours each semester shall constitute full-time graduate work.
2. A major subject allowed by the rules of candidacy for the degree shall be chosen; all major, minor, and supporting work shall be outlined in consultation with the head of the department in which the major is taken.
3. Unless otherwise specially permitted a graduate student shall carry at least one study of strictly graduate grade each semester. In any case at least four hours of strictly graduate work must be completed each year.
4. The course of study as outlined shall not be amended or changed except by the approval of the Dean of the Graduate Division, and any such change shall be in writing and shall be filed with the original course of study.
5. The courses of study as outlined shall be made out in triplicate: one shall be retained in the files of the department in which the major work is taken, one shall be filed in the office of the Dean of the Graduate Division, and one in the office of College Registrar. Each copy shall be signed by the head of the department in which the major work is taken, by the instructor who will have immediate charge of the major line of work, and by the Dean of the Graduate Division.
6. In special cases a *limited* amount of credit may be given in subjects not catalogued as graduate studies where these are taken as minors and bear directly upon the major subjects and are recommended by the professor in charge of the major work and approved by the Dean.
7. Graduate students who are not candidates for an advanced degree are not required to designate a major or a minor subject but may elect their work with a view to their special purpose. Any course of study in the Graduate Division is open for election by such students upon the same conditions that are imposed upon those who are candidates for a degree. If at any time such special students desire to become candidates for an advanced degree, due consideration and credit will be given for work already done.

NOTE: Any deficiency in Modern Language should be made up immediately. See requiriments in Modern Language for advanced degrees.

DEGREES

The higher degrees conferred by the Iowa State College are the Master of Science and Doctor of Philosophy for advanced work in the technical fields especially developed at this college; and the Professional Degrees of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), Engineer of Mines (E. M.), Ceramic Engineer (Cer. E.), Chemical Engineer (Ch. E.), Agricultural Engineer (A. E.), Master of Agriculture (M. Agr.), and Master of Forestry (M. F.)

THE MASTER'S DEGREE

The degree of Master of Science may be conferred upon students who have completed work in compliance with the following provisions and requirements:—

1. At least one year must be spent in resident work.
2. At least thirty credit hours or the equivalent must be completed, not less than half of which should be from this institution.
3. A minimum of twenty credit hours shall be completed in the major work, and a maximum of ten credit hours in the minor work. Minor work is recommended, and it may be taken in the same department in which the major is taken; but both major and minor may not be taken under the same instructor.
4. Major work may, upon special recommendation, be taken in two closely related subjects. In such a case a minor is optional.
5. A satisfactory reading knowledge of French or German must be certified to by the head of the Department of Modern Languages prior to admission to examination. Upon the recommendation of the head of the department some other modern language may be substituted for French or German.
6. Such subjects as are designated as "undergraduate and graduate" or "graduate" will be credited toward the advanced degree. Major work will ordinarily be restricted to graduate subjects. See 6 under Classification.
7. Thesis is optional with the department in which the major work is taken. Students should consult the Dean concerning the form of thesis.
8. Examination shall be taken on all graduate work including thesis when thesis is required. This shall be oral or written as determined by the instructors concerned.

THE MASTER'S DEGREE PARTLY IN ABSENTIA

Any graduate of Iowa State College or other institution of high standing may be permitted to do one-half the required work for the Master's Degree *in absentia* as follows: 1. The applicant must be in residence at this institution during at least three six-weeks summer sessions. 2. During the period of two consecutive years while not in residence at the College the candidate must pursue a course of advanced study previously arranged by the head of the department in which the work is to be done and which has been approved by the Dean of the Graduate Division. This

absentia work is expected to equal in amount that normally accomplished in three six-weeks summer sessions and is to lie along the line of his major work. Such special students are required to pass examinations on all work done at the College and *in absentia.*

ADVANCED STANDING

Graduate students of approved colleges and universities who have completed a portion of the requirements for the Master's or Doctor's degree in the technical lines developed at this institution, may be permitted to enroll as graduate students and finish their work for the desired degree. For the Master's degree at least one year of residence will be required, in which not less than fifteen credit hours of graduate work must be completed. For the Doctor's degree at least one year of residence will be required, in which not less than thirty credit hours of graduate work, inclusive of dissertation, must be completed.

THE DOCTOR'S DEGREE.

The degree of Doctor of Philosophy may be conferred upon students who complete work in compliance with the following provisions and requirements:—

1. Three years of graduate work are required, one of which must be spent at this institution.

2. The degree will be conferred not solely as a result of a faithful study over any period, but for ability to do research work of a scholarly character and for the successful passing of all examinations.

3 Major work shall be taken in one subject, or, in exceptional cases, in two closely related subjects. Two minors shall be taken when only one major is chosen, and one minor shall be taken when two majors are chosen.

4. Minor work shall represent from one-fourth to one-third of the work for the degree.

5. One minor must be taken outside the department in which the major is taken.

6. A reading knowledge of French and German must be certified to by the head of the Department of Modern Languages at least one year prior to final examination.

7. During the last two years of graduate work only such courses as are designated as "graduate" shall be credited on major work.

8. A thesis which is a real contribution to knowledge along some line in which the major is taken must be completed. The student should consult the Dean of the Graduate Division for information regarding the form in which the thesis must be presented.

9. Not later than April 1st of the academic year in which the degree is sought, the candidate shall have his thesis approved by the head of the department in which the major work has been taken, and submitted in typewritten form to the Dean of the Graduate Division.

10. Publication of the thesis by the candidate or by a scientific journal is required. In either case the degree will not be conferred until two type-

written copies of the thesis have been deposited in the library and a financial guarantee that fifty printed copies in approved form will also be deposited in the library.

11. The Dean of the Graduate Division shall appoint for each candidate an examining committee composed of five members, including the professors in charge of the major and minor work, the chairman of which shall be the professor in charge of the student's major work. The Dean shall also designate the time and place for the examination, which may be either oral or written or both, over the fields of the major and first minor. In case a second minor is chosen, the examination over it may be waived if the candidate's standing in it is satisfactory.

PROFESSIONAL DEGREES

Application for admission to candidacy for a professional degree in *Engineering* should be made to the Dean of Engineering prior to the beginning of the second semester of the year in which the degree is sought. The requirements may be met in any one of the three following ways:

1. Graduation from a regular four-year course in engineering, one year of resident study approved by the engineering faculty, at least one year of experience in a responsible professional position, and the preparation of a satisfactory thesis.
2. Graduation from a regular four-year course in engineering, at least five years of experience in a responsible professional position, and the preparation of a satisfactory thesis.
3. Graduation from a regular five-year course in engineering, at least one year of successful professional experience, and the preparation of a satisfactory thesis.

In *Agriculture and Engineering* the requirements for the degree of Agricultural Engineer are the same as those for the professional degrees in agriculture and engineering, and the candidate must be recommended by the faculties of both the Agricultural and Engineering Divisions.

In *Agriculture* the professional degree of Master of Agriculture is granted on the initiative of the faculty of the Division of Agriculture. The completion of a standard collegiate course in agriculture followed by not less than five years of eminently successful experience in some phase of practical or professional agriculture, and the presentation of an acceptable thesis are prerequisite.

It is the policy of the College to confer professional degrees only in cases of superior professional attainments, and then only on those who are present at Commencement.

FELLOWSHIPS AND SCHOLARSHIPS

For the promotion of graduate study and research the Board of Education has established at Iowa State College a number of fellowships and scholarships. Application blanks may be obtained from the Dean of the Graduate Division, and when filled out should be filed in his office.

Scholarships are given to holders of a baccalaureate degree and carry

with them a stipend of two hundred dollars payable in ten equal payments with the remission of tuition. All scholars pay a two dollar hospital fee, a fee of one dollar for each hour's work up to seven hours, and laboratory fees in their minor subjects only. Scholars are required to do at least three hours teaching a week or the equivalent.

Teaching Fellowships are open to graduates of approved institutions and carry with them a stipend of four hundred dollars with the remission of tuition. Teaching Fellows are required to do at least five hours of teaching a week or its equivalent. The fees for Fellows are the same as those for Scholars.

Junior and Senior Research Fellowships are open to graduates of approved institutions and have for their object the encouragement of research work. Junior Research Fellowships may be held during the first year of graduate study and carry with them a stipend of three hundred dollars with the remission of tuition. Senior Research Fellowships carry with them a stipend of five hundred dollars and are ordinarily not awarded except to those who have had at least one year of graduate study or research experience. Research Fellows in the experiment stations shall observe experiment station hours throughout the college year, except for the time given to minor work. The fees for all Fellows are the same as those for Scholars.

Full resident credit may be given for graduate work to holders of scholarships, and of teaching and research fellowships.

GRADUATE STUDY BY MEMBERS OF STAFFS

The members of the instructional and investigational force of the rank of instructor or assistant are permitted to do graduate work. Those on half-time employment may receive not to exceed two-thirds time credit, and those on full time may receive not to exceed one-fourth time credit. All adjustments as to the amount of credit to be allowed shall be made between the Head of the Department in which the work is taken and the Dean of the Graduate Division.

Members of the Experiment Stations whose ranks correspond to that of instructors or assistants in the College may carry a limited amount of graduate work subject to the approval of the President.

DEPARTMENTS OFFERING GRADUATE INSTRUCTION

Agricultural Education

Professor Wilson; Associate Professors Sealock, Fisher; Assistant Professor Gibson

The department offers to graduate students minor work only, except in special cases when major work limited to technical agricultural subjects may be taken.

For description of studies, see page 95.

Agricultural Engineering

Professor Costelloe; Associate Professor Mervine

The department offers major work for the degree of Master of Science in Agricultural Engineering along the lines of farm machinery, farm power, drainage, irrigation, rural sanitation, and farm structures; and minor work for students selecting major work in other departments.

For the requirements for the professional degree of Agricultural Engineer and description of subjects, see pages 72 and 103.

Animal Husbandry

Professors Pew, Turpin; Associate Professors Vaughan, Lloyd-Jones, Shearer, Ferrin, Ikeler; Assistant Chief Evvard; Assistant Professor Gillette

The department offers major and minor work for Master's degree along the lines of animal nutrition and feeding, animal breeding, live stock management, dairy husbandry, and poultry husbandry, and major and minor work for the Doctor's degree in nutrition, genetics, and dairy husbandry.

For description of subjects see page 117.

Architectural Engineering and Rural Structures

Professor Kimball

The department offers major and minor work leading to the degree of Master of Science in Architectural Engineering.

For description of subjects, see pages 126 and 129.

Bacteriology and Hygiene

Professors Buchanan, Brown, Hammer; Associate Professor Murray, Assistant Professor Levine

Major and minor work leading to the degrees of Master of Science and Doctor of Philosophy are offered in those phases of bacteriology which have important relations to agriculture, home economics, engineering, veterinary medicine, and the industries.

For description of subjects see page 132.

Botany

Professor Pammel; Associate Professors Martin, Melhus; Assistant Professor Bakke

The department offers major and minor work for the degrees Master of Science and Doctor of Philosophy in those fields of Botany which find their application in agriculture, horticulture, forestry, and the industries. For this purpose graduate and research work in vegetable pathology, morphology, physiology, systematic and economic botany are offered.

For description of subjects see page 138.

Ceramics

Professors Beyer, Staley; Assistant Professor Galpin

The department offers major and minor work for the degree of Master of Science along the lines of ceramic technology of crude and fine clay products, the technology of glass and enamel making, the geology of clays and ceramic materials, microscopic study of clays, and ceramic materials and cement making.

For description of subjects and professional degree see pages 149 and 72.

Chemical Engineering

Professors Beyer, Coover; Associate Professor Mann

Students majoring for advanced degrees in other departments of the Engineering, Industrial Science, and Agricultural Divisions may minor in chemical engineering. At the present time the department is not offering all of the requirements for the degree of Master of Science.

The Chemical and Engineering Departments are provided with facilities for investigation of manufacturing problems and for conducting industrial research according to a practical system of cooperation between science and industry. These facilities are open to graduate students in chemical engineering.

For professional degree and description of subjects see pages 72 and 155.

Chemistry

College Department Staff: Professor Coover; Associate Professors Fowler, Test, Wilkinson, Renshaw, Mann; Assistant Professors Buchanan, Hall. Agricultural Experiment Station Staff: Chief Dox. Engineering Experiment Station Staff: Chief Coye.

The Department of Chemistry offers major and minor work for the Master's and Doctor's degrees in those fields of chemistry applicable to agriculture, engineering, home economics, veterinary medicine, and the industries.

In the Agricultural Experiment Station thesis work is offered in agricultural and biological chemistry. In the Engineering Experiment Station thesis work is offered in industrial chemistry and the chemistry of road materials.

For description of subjects see page 158.

Civil Engineering

Professors Kirkham, King, Agg; Associate Professors Evinger, Crum

The department offers major work for the degree of Master of Science in Civil Engineering along the lines of masonry structures and experimental engineering, railway engineering, structural engineering, hydraulic and sanitary engineering, masonry design, highway engineering; and minor and supporting work in the other departments of the Engineer-

ing, Agricultural, and Industrial Science Divisions. Students may therefore major in civil engineering and minor in any department of the Agricultural and Industrial Science Divisions which offers a correlated line of work, and vice versa.

For the professional degree of Civil Engineer and for the description of subjects, see pages 72 and 175.

Dairying

Professors Mortensen, Hammer; Assistant Professor Rudnick

The Department of Dairying offers major and minor work for the Master's degree along the lines of management of dairy plants, dairy bacteriology, and creamery products. In correlation with the fundamental sciences the department also offers major and minor work for the Doctor's degree in management of dairy plants and dairy bacteriology.

For description of subjects see page 187.

Economic Science

APPLIED ECONOMICS AND SOCIAL SCIENCE

Professor Brindley; Associate Professors Von Tungeln and Rankin; Instructor Baker

Major work leading to the degree of Master of Science may be taken in either of the specialized fields, agricultural economics, or rural sociology.

The student taking major work in applied economics and social science should take supporting work in history and psychology and in agriculture, engineering, or home economics.

For description of subjects see page 190.

Electrical Engineering

Professor Fish; Associate Professors Bartholomew, Wright; Assistant Professors Robbins, Paine

The Department of Electrical Engineering offers opportunity for major work leading to the degree of Master of Science in Electrical Engineering. The subjects offered are advanced theory of alternating currents, electric power transmission, electric railways, and advanced work on the operating characteristics of electrical apparatus.

For the requirements for the professional degree of Electrical Engineer and description of the studies see pages 72 and 200.

Farm Crops and Soils

Professors Stevenson, Hughes, Brown; Associate Professors Smith, Potter; Chief Burnett

Graduate work comprises investigations in the two general fields of soils and of farm crops. Major and minor work for the Master's degree are offered along the lines of crop production, crop breeding, soil physics, soil fertility, soil bacteriology, soil humus, and soil management. For the Doctor's degree, major and minor work are offered in soil fertility, soil bacteriology, and soil humus.

In order to register for graduate work in farm crops and soils, the student's baccalaureate degree must be in Agronomy and from an institution of recognized standing.

For description of subjects, see pages 211 and 214.

Farm Management

Professor Munger; Assistant Chief Lloyd

Major and minor work for the Master's degree is offered in Farm Management. The problems which may be pursued include farm surveys, cost accounting, land tenure, and farm tenancy.

For description of subjects see page 220.

Forestry

Professor Beach, MacDonald; Associate Professor Morbeck

The department offers major and minor work leading to the degree Master of Science in Forestry. Also a five-year outlined course, developed along the lines of forest protection, forest management, lumbering, and forest products, and leading to the same degree, is maintained for the special benefit of students who, at the beginning of their Freshman year, decide to spend five years in the study of Forestry.

For equipment and description of studies see page 229.

Geology

Professor Beyer; Assistant Professor Galpin

The department offers major and minor work for the Master's degree along those lines in which geology has an intimate relationship to mining engineering, soil formation, etc. The department also offers major work for the degree of Doctor of Philosophy in the fields of economic geology and petrology.

For equipment and description of subjects see page 237.

Home Economics

Professor MacKay; Associate Professors Gettemy, Monsch, Brandt, Fisher; Assistant Professors Humphrey, Olsen, Witwer, McNeal

Opportunities are offered for graduate study leading to the Master's degree in Home Economics. The major part of the graduate work is offered in the fields of chemistry, bacteriology, economic science, physiology, etc., which have special application to home economics. Each student, therefore, chooses her major graduate work in the particular field in which she wishes to specialize.

For description of subjects see page 249.

Horticulture

Professor Beach; Chiefs Erwin, Greene; Associate Professors Culley, Harrington; Assistant Professor Thurston

The department offers major and minor work for the Master's degree along the lines of general horticulture, pomology, truck crops, landscape

gardening, and floriculture; and major and minor work for the Doctor's degree along the lines of plant breeding and pomology.

For description of subjects see page 264.

Mathematics

Professors Stanton, Roberts; Associate Professors Colpitts, Pattengill, Chaney, Snedecor; Dr. Tappan

Major and minor work for the degree of Master of Science is offered by the department. Special courses in advanced mathematics of engineering, physics, economic problems, statistics, and biological problems are so correlated with the technical lines of work as to demand consideration of all students who expect to teach applied mathematics in technical institutions or to become investigators in any of the above lines of work.

For description of subjects see page 279.

Mechanical Engineering

Professor Meeker; Associate Professors Cleghorn, Major, Norman, Leavell

The department offers major work for the degree of Master of Science in Mechanical Engineering along the lines of gas engineering, steam engineering, heating and ventilation, machine designing, railway mechanical engineering, automobile engineering; and minor and supporting work in the other departments of the Engineering, Agricultural, and Industrial Science Divisions.

For the professional degree of Mechanical Engineer and description of subjects see pages 72 and 293.

Mining Engineering

Professor Beyer; Associate Professor Hodson

All of the subjects offered are required of undergraduates who specialize in Mining Engineering and Metallurgy, but may be elected for minor work by graduates who are majoring along other lines. The department does not, at the present time, offer major work for an advanced degree.

For professional degrees and description of subjects see pages 72 and 308.

Physics

Professor Spinney; Associate Professors Stiles, Thompson, Kunerth; Assistant Professor Plagge

The Department of Physics offers major and minor work leading to the degree of Master of Science in those fields of physics which are related to industrial science, engineering, home economics, and agriculture.

For equipment and description of subjects see page 320.

Veterinary Anatomy

Professor Murphey

Major and minor work for the degree of Master of Science is offered by the department in histology and in gross anatomy. Minor work in

anatomy is suggested for students majoring in animal nutrition, biological chemistry, pathology, physiology, and zoology.

For equipment, specimen collection, and description of subjects see page 329.

Veterinary Pathology and Bacteriology

Professor Dimock; Associate Professor Murray

The department offers major and minor work leading to the Master's degree along the lines of systemic pathology, the pathology of specific infectious diseases, the pathology of sporadic diseases, tumors, chemical pathology, veterinary bacteriology, immunity and serum therapy.

Students who major in veterinary bacteriology including immunity and serum therapy will classify with the Department of Bacteriology in the Industrial Science Division, but will do their work in the Department of Veterinary Pathology and Bacteriology. Students who major in pathology will classify in the Department of Veterinary Pathology and Bacteriology.

For description of subjects see page 332.

Veterinary Physiology and Pharmacology

Professor Bergman

The department offers major work for the Master's degree along lines of investigation of physiological subjects relating to veterinary science; and minor and supporting work in physiology for graduate students in science, or for agricultural students who are doing their work along such lines as general nutrition, production problems, feeding, breeding, etc.

For description of subjects see page 335.

Zoology

Professor Summers; Associate Professors Guthrie, Bartholomew, Ewing; Assistant Professors Harrison, Scullen

The department offers major and minor work for the Master's degree along the lines of entomology, comparative physiology, invertebrate and vertebrate comparative anatomy; and major work for the Doctor's degree along the lines of entomology and comparative physiology.

For description of studies and equipment see pages 344 and 341.

DEPARTMENTS OFFERING MINOR WORK ONLY

The work in the following departments is undergraduate in character and is subordinate and auxiliary to the work of the departments which offer major lines.

History

Professor Cessna; Associate Professor Schmidt

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in history. The chief purpose of this work is to furnish an historical foundation for

the study of the present day economic and social problems in technical fields. The new trend in historical science has brought the study of history into a very fundamental relation to the industrial sciences.

For a statement of the nature of the work and description of studies, see page 240.

Psychology

Professor Cessna; Associate Professor Vance

Students majoring for advanced degrees in agriculture or industrial science or applied economics and social science may minor in psychology. It is evident that all subjects involving the human element must be based on the knowledge of the laws of mental action. The study of psychology is regarded as necessary to the proper understanding of industrial development and efficiency.

For a statement of the nature of the work and description of studies, see page 323.

the success of farming as found in farm surveys; types of farming, farm layout, forms of tenure and leases, organization and management of successful farms.

6th or 7th Sem. Lectures and recitations 2; lab. 1, 2 hr.; credit 2⅔; fee $1.00.

3. **Advanced Farm Management.** A further study of farm organization and management. Field trips for the study of successful farms. One two-day trip will be required during the semester for the study of farms in surveyed areas.

7th Sem. Prerequisites 1 and 2; lecture 1; lab. 1, 3 hr.; credit 2; fee $1.00.

4. **Research.** Investigation by the student of a special farm management problem. Students should present a satisfactory problem before registering.

7th or 8th Sem. Prerequisites 1 and 2, preceded or accompanied by 3; lab. 15 hrs.; credit 5.

5. **Thesis.** Investigation of a problem requiring original work.

7th or 8th Sem. Prerequisites 1 and 2; lab. 9 hrs.; credit 3.

6. **Seminar.** Problems, discussions, and talks relating to farm management.

5th and 6th Sem. Session, 1 every 2 wks.; credit 1.

7. **Research.** Original investigation of a special farm management problem. PROFESSOR MUNGER; ASSISTANT-CHIEF LLOYD

Either Sem.

8. **Seminar.** Continuation of 6.

7th and 8th Sem. Session, 1 every 2 wks.; credit 1.

FORESTRY

PROFESSOR BEACH, Agricultural Hall, Room 201
PROFESSOR MACDONALD, Agricultural Hall, Room 229
Associate Professor Morbeck; Assistant Professor Truax; Extension Worker Pearse

For information concerning the Division of Agriculture, see page 56.

General Work in Forestry. The Department is providing for adequate instruction in the branches of forestry important to Iowa. The work in general forestry has its application on every farm in the State, as well as on the 2½ million acres of natural forest land and waste areas unsuited for agricultural crops. The general work in this subject includes the windbreak and shelterbelt in its relation to the farm; the place of the woodlot on the farm; and the utilization of native timbers for fence posts and for various other purposes.

Forest Management. The rapid development of forestry in the past few years has created a large demand for trained foresters. Although forestry is a comparatively new profession in this country, positions are available in a number of lines. The National Government yearly employs a large number of trained men to administer and care for the National Forests consisting of approximately 185,000,000 acres. Graduates of forestry schools usually enter the Forest Service by passing a civil service

examination for the position of forest assistant, which pays $1100 and traveling expenses at the start. Others enter the government work as forest rangers. The Philippine forest service also offers good opportunities at a larger salary.

Second only to the National Government in the practice of forestry is the state. Many states have already acquired forest lands and are employing foresters at good salaries. State work will require an increasing number of trained men.

Besides the government and state work there are many foresters in the employment of municipalities, railroads, lumber companies, and private estates. These are the fields which will show the greatest development in the future and in which trained foresters will be required in large numbers.

The field of forest investigations is in need of men specially trained. The importance of this line will increase as forestry develops, and will require an increasing number of investigators. Closely related to this line is that of teaching. The demand for instruction and education in forestry increases as its importance becomes known. Many foresters will find employment here.

The four-year course leading to the degree of Bachelor of Science in Forestry has been developed with the idea of giving a sound foundation in the sciences and related subjects as well as a good training in technical forestry. Graduates of the four-year course are able to pass into government, state, and private work at once. The course is designed to give the student a good training in practical work as well as in theory and principle. The five-year course leading to the degree of Master of Science in Forestry provides for additional specialization along one of several lines of work.

Lumber Marketing Group. Opportunity is given to students especially interested in the manufacture and marketing of forest products to pursue work along these lines in the senior year. A lumber marketing group comprising two full semesters' work is offered, which covers the field of manufacturing and marketing of lumber and is designed to give the student a good working knowledge of this particular phase of forestry. Students completing this group should be well equipped to engage in the buying and selling of lumber, either at retail or wholesale. There are good opportunities in Iowa for men trained in these lines, as well as in the other large lumber consuming states. The retailing of lumber will be emphasized and the marketing group should be of especial value to those who contemplate entering the field of retail lumbering.

City Forestry. An opportunity is now offered for a combined training in Forestry and Landscape Gardening to fit men for the position of City Forester. After completing the Four-Year Forestry Course, if the student has availed himself of the opportunity to take certain optional subjects in the Junior and Senior years, he may take an additional year's work in Landscape Gardening, and on satisfactory completion of the prescribed course may receive the corresponding Bachelor of Science degree in Land-

scape Gardening (see page 263.) There is an increasing demand for men fitted for the City Forestry position.

Summer Camp. In addition to the laboratory and field work at the college, the students are required to spend twelve weeks in summer camp in some good forest region of the country. The entire time is spent in field operations, consisting of the estimating of timber, mapping the forest types, making volume tables, and the studying of logging and milling operations. The general equipment for the camp, such as tents and field instruments, is furnished by the College; the student is required to furnish bedding and personal effects. The 1916 camp was held in lumbering regions of Colorado, Utah, California, Oregon, Washington, Idaho, Montana, and Minnesota. The 1917 camp will probably be held in Iowa and Minnesota.

Forestry Club. The students of the Forestry Department of the College are organized into a Forestry Club. Meetings are held every two weeks at which addresses on forestry subjects are given. The Club publishes an annual, "The Ames Forester," which is a technical journal of about 100 pages.

Equipment. Forestry is housed in Agricultural Hall where ample laboratory and class room is afforded. The museum contains the collection of American woods which was exhibited by Iowa at the Centennial exposition and a large collection of South American and Philippine Island woods which was on display at the Louisiana Purchase exposition. It also contains a large number of trunk specimens of trees. About 1000 lantern slides are used for illustrating, in the class room, the various phases of forestry work as carried on in different parts of the United States and foreign countries. A wooded tract of about 100 acres belonging to the department serves as a demonstration area and affords ample room for the establishment and maintenance of forest plantations. The College campus has about 150 different species of trees, and there are also numerous old plantations in the vicinity.

Four-Year Course in Forestry

Leading to the degree of Bachelor of Science in Forestry.

Students receiving the degree of B. Sc. in Forestry for the completion of this course are eligible for the degree given for Landscape Gardening work, upon completion of the additional year's work outlined on page 263.

Forestry students are required to complete 3 months of practical forestry work before graduation, in addition to the summer camp.

FRESHMAN YEAR

First Semester	Credits[2]	Second Semester	Credits
For. 26[1]: General Forestry	2	For. 27: General Forestry	2
For. 38: Forestry Publications	1/3	Bot. 269: Plant Physiology	3 1/3

[1] The number refers to the description of the study.
[2] For definition of a credit see page 91.

Bot. 127: General Botany	5	Chem. 104: General Chemistry and Qualitative Analysis	4
Chem. 103: General Chemistry	4	Engl. 19: Exposition	3
Engl. 18: Narration and Description	3	Hist. 20: Industrial History of U. S.	2
Lib. 1: Library Instruction	R[3]	Math. 30: Plane Trigonometry	3
Math. 40: College Algebra	3	Mil. 2: Military Drill	R
Mil. 1: Military Drill	R	Phys. Tr. 2: Physical Training	R
Phys. Tr. 1: Physical Training	R		
	17⅓		17⅓

SOPHOMORE YEAR

Third Semester	Credits	Fourth Semester	Credits
For. 52: Silviculture	3	For. 32: Forest Mensuration	2
For. 54: Lumbering	3	For. 53: Forest Planting	3⅓
For. 55: Forest Products	2	For. 59: Wood Technology	3
Bot. 26: Ecology	1⅔	Bot. 407: Dendrology	4⅔
Chem. 351: Applied Organic	3⅔	C. E. 406: Surveying	2
M. E. 121: Mechanical Drawing	2	Mil. 4: Military Drill	R
Mil. 3: Military Drill	R	Phys. Tr. 4: (Elective)	
Phys. Tr. 3: (Elective)		Phys. 422: General Physics	3
Phys. 321: General Physics	3		
	18⅓		18

SUMMER CAMP

The following courses of instruction are carried on in the summer camp for forestry students. The camp course occupies twelve weeks during the summer between the Sophomore and Junior years.

	Credits
For. 36: Applied Lumbering	3
For. 56: Camp Technique	1
For. 57: Applied Forest Mensuration	5
For. 58: Field Silviculture	3
	12

JUNIOR YEAR

Fifth Semester	Credits	Sixth Semester	Credits
For. 11: Forest Protection	1	For. 18: Forestry Seminar	R
For. 12: Forest Administration	2	For. 31: Timber Preservation	1
For. 18: Forestry Seminar	R	For. 46: Grading Lumber	1
For. 33: History of Forestry	1	Bot. 470: Systematic Phanerogams	2⅔
*For. 61: Forest Mapping	1		

[3] R indicates that the study is required, without credit, for graduation.

C. E. 557: Surveying	4	Bot. 564: Range and Poisonous Plants	1⅔
Econ. Sci. 123: Forest Economics	3	Chem. 370: Chemistry of Forest Products	3⅓
Soils 128: Physics of Forest Soils	3⅓	*C. E. 658: Surveying	4
**Zool. 304: General Entomology	3⅓	Zool. 336: Forest Entomology	2⅔
		Elective	1
	18⅔[5]		17⅓[5]

* Students who expect to complete the additional year's work for the degree of B. Sc. in Landscape Gardening, after finishing the Four-Year Course in Forestry, should take Hort. 407, Landscape Gardening, 2 hrs., in place of Forestry 61; Hort. 419, Landscape Design, 2 hrs.; and Hort. 409, Plant Materials, 1⅔ hrs., in place of C. E. 658. In this case C. E. 658 would be taken in the tenth semester.
** Optional with Zool. 46, General Zoology, 3⅓.

*** Forest Management Group

SENIOR YEAR

Seventh Semester	Credits	Eighth Semester	Credits
For. 9: Forest Management	2	For. 10: Forest Valuation	2
For. 19: Forestry Seminar	R	For. 19: Forestry Seminar	R
Agr'l Jour. 8: Beginning Technical Journalism	2	For. 34: State and National Forest Law	2
*Bot. 365: Forest Pathology	3	Bact. 19: General Bacteriology	2⅔
Geol. 10: Agricultural Geology	4	C. E. 659: Timber Testing	1⅔
*Hort. 407: Landscape Architecture	2	*Econ. Sci. 326: Business Law	2
Pub. Sp. 10: Extempore Speech	2	Hort. 418: Shade and Street Tree Management	2⅓
Soils 119: Forest Physiography and Soil Surveying	2⅔	Electives	1
		**Specified Electives	4
	17⅔		17⅔

* Students who expect to complete the additional year's work for the degree B. Sc. in Landscape Gardening, after finishing the Four-Year Course in Forestry, should take Hort. 410, Plant Materials, 1⅔ hrs.; Hort. 411, History of Landscape Gardening, 2 hrs.; Hort. 420, Landscape Design, 3 hrs.; in place of Bot. 365, Hort. 407, and elective subjects.

Also in the eighth semester the student should take Hort. 2, Horticultural Practice, 2⅔ hrs., and Hort. 421, Landscape Design, 3 hrs.; Hort. 422, Planting Plans, 1 hr.; in place of Econ. Sc. 326, electives, and specified electives.

** Choice of two subjects: Agr'l Jour. 9, Tech. Jour. Practice (2 credits); Pub. Sp. 11, Extempore Speech (2); Engl. 412, Argumentation (2); Engl. 29, Lit. of Farm and Community Life (2).

*** The student should choose either the Forest Management or the Lumber Gardening Group at the beginning of the Senior year.

Lumber Marketing Group

SENIOR YEAR

Seventh Semester	Credits	Eighth Semester	Credits
For. 19: Seminar	R	For. 19: Forestry Seminar	R

[5] In the Junior and Senior years the credits may be increased to twenty for each semester with the consent of the Dean of Agriculture.

For. 62: Commercial Woods	2	For. 45: Advanced Wood Structure	3
For. 63: Lumber Markets	3	Agr'l Jour. 7: Agricultural Advertising	1
For. 64: Lumber Transportation	1	C. E. 659: Timber Testing	1⅔
Agr'l Jour. 8: Tech. Journalism	2	Econ. Sci. 326: Business Law	2
Econ. Sci. 327: Elementary Accounting	2⅓	Econ. Sci. 332: Advanced Accounting	2
Psych. 10: Psychology of Business	2	Electives	7⅓
Pub. Sp. 10: Extempore Speech	2		
Electives	3		
	17⅓		17

Additional Forestry Year for Landscape Students*

Graduates in the course in Landscape Gardening (page 261) who have credits in Forestry 18, 26, 27, 32, 52, 54, 55, and Botany 407, will be recommended for the degree of Bachelor of Science in Forestry on the completion of Forestry 36, 56, 57, 58 (Summer Camp), and the additional year's work listed below.

Fall Semester	Credits	Spring Semester	Credits
For. 9: Forest Management	2	For. 10: Forest Valuation	2
For. 11: Forest Protection	1	For. 19: Seminar	R
For. 12: Forest Administration	2	For. 31: Timber Preservation	1
For. 19: Seminar	R	For. 34: State and National Forest Laws	2
For. 33: History of Forestry	1	For. 41: Municipal Forestry	1
Bot. 26: Ecology	1⅔	For. 53: Forest Planting	3⅓
Bot. 365: Forestry Pathology	3	For. 59: Wood Technology	3
Ec. Sci. 123: Forest Economics	3	Bot. 564: Range and Poisonous Plants	1⅔
Soils 119: Soil Surveying	2⅔	Chem. 370: Chemistry of Forest Products	3⅓
Choice: Agr'l Jour. 9: Journalism Practice (2); Engl. 412: Argumentation (2); Pub. Sp. 10: Extempore Speech (2)	2	C. E. 659: Timber Testing	1⅔
	18⅓		19

* For additional Landscape Gardening year for Forestry students, see page 263.

Five-Year Course in Forestry

The degree Bachelor of Science in Forestry is given after the completion of four years' work, and the degree Master of Science in Forestry after the fifth year.

Forestry students are required to complete 3 months of practical forestry work before graduation, in addition to the summer camp.

FRESHMAN YEAR

First Semester	Credits[2]	Second Semester	Credits
For. 26[1]: General Forestry	2	For. 27: General Forestry	2
For. 38: Forestry Publications	⅓	Bot. 269: Plant Physiology	3⅓
Bot. 127: General Botany	5	Engl. 19: Exposition	3
Engl. 18: Narration and Description	3	Hist. 20: Industrial History of the United States	2
Lib. 1: Library Work	R[3]	Math. 30: Plane Trigonometry	3
Math. 40: College Algebra	3	Mil. 2: Military Drill	R
Mil. 1: Military Drill	R	Mod. Lang. 6: Elementary German	5
Mod. Lang. 5: Elementary German	5	Phys. Tr. 2: Physical Training	R
Phys. Tr. 1: Physical Training	R		
	18⅓		18⅓

SOPHOMORE YEAR

Third Semester	Credits	Fourth Semester	Credits
For. 52: Silvilculture	3	For. 32: Forest Mensuration	2
For. 54: Lumbering	3	Bot. 407: Dendrology	4⅔
Chem. 103: General Chemistry	4	Chem. 104: General Chemistry and Qualitative Analysis	4
M. E. 121: Mechanical Drawing	2	C. E. 406: Surveying	2
Mil. 3: Military Drill	R	Mil. 4: Military Drill	R
Mod. Lang. 16: Scientific German	3	Mod. Lang. 17: Scientific German	3
Phys. Tr. 3: (Elective)		Phys. Tr. 4: (Elective)	
Phys. 321: General Physics	3	Phys. 422: General Physics	3
	18		18⅔

SUMMER CAMP

	Credits
For. 36: Applied Lumbering	3
For. 56: Camp Technique	1
For. 57: Applied Forest Mensuration	5
For 58: Field Silviculture	3
	12

JUNIOR YEAR

Fifth Semester	Credits	Sixth Semester	Credits
For. 11: Forest Protection	1	For. 18: Forestry Seminar	R

[1] The number refers to the description of the study.
[2] For definition of a credit see page 91.
[3] R indicates that the study is required, without credit, for graduation

For. 18: Forestry Seminar	R
For. 55: Forest Products	2
For. 61: Forest Mapping	1
Bot. 26: Ecology	1⅔
Chem. 351: Applied Organic	3⅔
C. E. 557: Surveying	4
Soils 128: Physics of Forest Soils	3⅓
Electives	1-2
	17⅔-18⅔[5]

For. 53: Forest Planting	3⅓
For. 59: Wood Technology	3
Bot. 470: Systematic Spermatophytes	2⅔
Chem. 370: Chemistry of Forest Products	3⅓
C. E. 658: Surveying	4
C. E. 659: Timber Testing	1⅔
	18[5]

SENIOR YEAR

Seventh Semester	Credits
For. 9: Forest Management	2
For. 19: Forestry Seminar	R
For. 33: History of Forestry	1
Econ. Sci. 123: Forest Economics	3
Geol. 10: Agricultural Geology	4
Hort. 407: Landscape Architecture	2
Soils 119: Forest Physiography and Soil Surveying	2⅔
Zool. 304: General Entomology	3⅓
	18[5]

Eighth Semester	Credits
For. 10: Forest Valuation	2
For. 19: Forestry Seminar	R
For. 31: Timber Preservation	1
Agr'l Jour. 8: Beginning Technical Journalism	2
Bact. 19: General Bacteriology	2⅔
Bot. 564: Range and Poisonous Plants	1⅔
Econ. Sci. 326: Business Law	2
Hort. 418: Shade and Street Tree Management	2⅓
Zool. 336: Forest Entomology	2⅔
Electives	1-2
	17⅓-18⅓[5]

POST-SENIOR YEAR

Ninth Semester	Credits
For. 12: Forest Administration	2
For. 40: Practice of Forestry	2
Bot. 124: Plant Embryogeny	1⅔
Bot. 365: Forest Pathology	3
Choice: Agr'l Jour. 9: Technical Journalism Practice 2; Engl. 412: Argumentation 2; Engl. 29: Literature of Farm and Community Life 2	2

Tenth Semester

For the second semester of the Post-Senior Year the student should choose one of the four following groups:

(Forest Management Group)	Credits
For. 13: Thesis	2
For. 34: State and National Forest Laws	2
For. 41: Municipal Forestry	1
For. 42: Advanced Forest Management	3
For. 43: Advanced Forest Regeneration	2
For. 44: Forestry Research	6
Elective	1
	17[5]

[5] In the Junior and Senior years the credits may be increased to twenty for each semester with the consent of the Dean of Agriculture.

Hort. 4: Plant Genetics	2⅔
Pub. Sp. 10: Extempore Speech	2
Electives	2-3
	17⅓-18⅓[5]

(Forest Products Group)

For. 13: Thesis	2
For. 44: Forestry Research	4
For. 45; Advanced Wood Structure	3
For. 46; Grading Lumber	1
Chem. 372: Chemistry of Forest Products	4
Electives	3
	17[5]

(Lumbering Group)

For. 13: Thesis	2
For. 44: Forestry Research	4
For. 46: Grading Lumber	1
For. 47: Advanced Lumbering	3
Agr'l Engr. 1: Shop Work	1
Electives	6
	17[5]

(Forest Protection Group)

For. 13: Thesis	2
For. 44: Forestry Research	4
For. 48: Advanced Forest Protection	3
Bact. 5: Advanced Bacteriology	4
Bot. 185: Experimental Morphology	1⅔
Electives	2
	16⅔

Description of Studies

Groups	Undergraduate	Undergraduate and Graduate
General Forestry	2[1], 38, 65	13, 18, 19, 26, 27, 33, 40
Forest Management		9, 10, 11, 12, 32, 34, 41, 42, 43, 44, 48, 52, 53, 61
Forest Utilization		31, 44, 45, 46, 47, 50, 51, 54, 55, 59, 60, 62, 63, 64
Summer Forestry Camp		36, 56, 57, 58

2. **Field Forestry.** An extension of the work in 65. Field excursions and laboratory exercises.

Any Sem. Field and lab. 2 hrs.; credit ⅔.

9. **Forest Management.** Management of government, state, and private forests. Regulation of the forest for a sustained yield. Forest working plans for National, private, and European forests.

7th Sem. Prerequisites 11, 32, 52; recitations 2; credit 2.

10. **Forest Valuation.** The principles underlying the determination of the value of forest lands. Compound interest formulæ used in forest calculations. The cost, sale, rental, and expectation values with reference to the forest. The assessment of damages to forest property, especially those resulting from fire.

8th Sem. Prerequisites, Econ. Sci. 123, For. 9 and 11; recitations 2; credit 2.

11. **Forest Protection.** Injury to the forest by trespass, grazing of animals, and atmospheric influences. The destruction of the forests by fires; means of prevention and suppression. Detailed fire plans for specified regions.

5th Sem. Recitation 1; credit 1.

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[1] The number refers to the description of the study.

[5] In the Junior and Senior years the credits may be increased to twenty for each semester with the consent of the Dean of Agriculture.

12. **Forest Administration.** Administration of National Forests; organization of field and office forces. Construction of permanent improvements such as roads, trails, bridges, fences, cabins, fire look-out towers, telephone lines, etc. Policy in grazing work, reforestation, timber sales, claims, trespass, free use, special use, water power, etc. Forest Service accounting.
5th Sem. Recitations 2; credit 2.

13. **Thesis.** An original investigation in advanced technical work, the subject to be chosen after consultation with the Forestry faculty. Thesis may be worked in connection with other research.
10th Sem. Credit 2.

18. **Forestry Seminar.** A meeting, one period in two weeks, for the discussion of current forestry topics. Subjects are assigned for discussion in consultation with the Forestry faculty.
Required of Junior Forestry students.

19. **Forestry Seminar.** A continuation of 18.
Required of Senior Forestry students.

26. **General Forestry.** The forest resources of the United States. Relation of the forest to the industries. The principles and scope of forestry. The subject is designed to give the technical student a general survey of the field of forestry.
1st Sem. Recitation 1; recitation and lab. 1, 2 hr.; credit 2.

27. **General Forestry.** A continuation of 26.
2nd Sem. Recitation 1; recitation and lab. 1, 2 hr.; credit 2.

31. **Timber Preservation.** Importance of wood preservation, including its relation to forest conservation and management. Causes of decay. Seasoning of timbers for treatment, chemicals used, methods of application, timber-treating plants. Preservative treatment of cross-ties, structural timbers, posts, poles, mine timbers, piling, paving blocks, etc.; effect of preservation upon the strength of timber.
6th Sem. Recitation 1; credit 1.

32. **Forest Mensuration.** Construction of log rules. Scaling logs. The use of forest instruments. The construction and use of form factors and volume tables. Determining the age and volume of trees and stands. Stump and tree analysis. The methods of estimating standing timber both private and national.
4th Sem. Recitations 2; credit 2.

33. **History of Forestry.** The development of forestry in the different countries from the earliest periods to the present time. Special emphasis is placed on the development in Germany, France, Austria, and Switzerland where scientific forestry has reached its highest development.
5th Sem. Recitation 1; credit 1.

34. **State and National Forest Laws.** The laws of the different states and the national government relating to forestry and forest protection. State and national forest policy. The establishment of National Forests.
6th Sem. Recitations 2; credit 2.

36. **Applied Lumbering.** Logging and milling operations, including a detailed study of each operation in the production of lumber. Tools and machines used, and costs of operations. The consideration of a specified tract of timber for logging; location of camps, roads, railroads, chutes. Equipment necessary, and estimated cost of each operation.

Summer Camp. Prerequisite 54; credit 3.

38. **Forestry Publications.** Designed for the beginning technical forestry student. To acquaint him with the available literature on forestry, including books, periodicals, government circulars and bulletins, state bulletins, experiment station reports, lumbering journals, and other publications along technical lines relating to forestry.

1st Sem. Six lectures during term. Credit ⅓.

40. **Practice of Forestry.** Present forestry practice in European countries, on national forests, in state forest reserves, with lumber corporations, and on private timber holdings.

9th Sem. Prerequisite 52; recitations 2; credit 2.

41. **Municipal Forestry.** Its place in the conservation movement. The economic value of the forest to the community. Utilization of waste lands. Organization, personnel, and management of city forests in European countries. Revenue from city forests as a means of reducing taxes. Service as recreation grounds, game preserves, parks, and health resorts.

10th Sem. Recitation 1; credit 1.

42. **Advanced Forest Management.** Special problems in regulation of yield in the forest. Construction of working plans. Assessment of damages to forest property. Field investigations and reports on forest lands within Iowa. PROFESSOR MACDONALD

10th Sem. Prerequisite 9, 10, 11, 52; credit 3.

43. **Advanced Forest Regeneration.** In connection with 42. Nursery methods, seeding and planting. The preparation of planting plans for specific areas. Methods of increasing forest productivity in native stands and plantations by artificial means. Field work given an important place.

PROFESSOR MACDONALD

10th Sem. Prerequisite 53; credit 2.

44. **Forestry Research.** Special investigations chosen in conference with the Forestry faculty. PROFESSOR MACDONALD

10th Sem. Credit 2 to 12.

45. **Advanced Wood Structure.** Special investigation for advanced students in the structure of wood. PROFESSOR MACDONALD

8th Sem. Prerequisite 59; credit 3.

46. **Grading Lumber.** Origin and development of grading rules for lumber. Various rules employed in grading lumber in lumbering regions. The grading of by-products of lumber mills.

ASSOCIATE PROFESSOR MORBECK

10th Sem. Prerequisites 36, 54; credit 1.

47. **Advanced Lumbering.** Special investigation in logging, milling, transportation, and marketing forest products.

ASSOCIATE PROFESSOR MORBECK

10th Sem. Prerequisites 36, 54, and 55; credit 3.

48. **Advanced Forest Protection.** Injuries to forests, especially by fire. The preparation of fire plans. Timber protective associations and their work. The duty of the state toward the preservation and protection of the forests. ASSOCIATE PROFESSOR MORBECK

10th Sem. Prerequisite 11; recitations 3; credit 3.

50. **Economic Woods.** Identification of woods by microscope and by gross characters. The elements which influence the mechanical and other properties. The uses of the various woods in the arts. The supply of the important timbers. Woods as substitutes.

1st, 3rd, 5th, or 7th Sem. Lecture 1; lab. 2 hrs.; credit 1⅔.

51. **Timber Preservation.** Methods of seasoning wood. Effect of seasoning on strength and durability. The development of wood preservation in the United States. Methods of preservation, and preservatives used with reference to treatment of railroad ties, construction timbers, paving blocks, poles, and posts. Woods used for various purposes under treatment. Cost of treating various classes of timbers.

2nd, 4th, 6th, or 8th Sem. Lectures 2; credit 2.

52. **Silviculture.** The factors responsible for the development of various forms of forest growth. The development of forest trees, including growth, form, age, and reproduction. Temporary and permanent forest types. The distribution of forest areas from a silvicultural standpoint. The treatment of woodlands; care at different stages of growth. Silvicultural systems of management with their application. Improvement cuttings.

3rd Sem. Recitations 3; credit 3.

53. **Forest Planting.** Methods of collecting and storing tree seeds. Regions of collecting. Testing vitality of seeds. Direct seeding. Nursery practice, including seed bed methods, transplanting and care of young trees. Field planting. Consists of lectures, readings, laboratory and field work.

4th and 6th Sem. Prerequisite 52; recitations 2; field and lab. 4 hrs.; credit 3⅓.

54. **Lumbering.** Standing timber in the United States, location, amount, species, value; the development of the industry. Logging and milling. The grading, selling, shipping, and marketing of lumber. Timber bonds. Operations in the various forest regions of the United States, giving especial emphasis to a comparison of the costs of logging and manufacture.

3rd Sem. Recitations 3; credit 3.

55. **Forest Products.** The manufacture of pulp and paper, shingles, lath, cooperage stock, veneer, excelsior, boxes, railroad ties, posts, and poles. The distillation of wood for the production of wood alcohol, charcoal, turpentine, resin. The production of tannin and essential oils.

3rd and 5th Sem. Recitations 2; credit 2.

56. **Camp Technique.** Personal equipment for camp life; camp and cooking equipment. Camp food. Ration lists for trips of different kinds. Useful knots. Practice in throwing various packing hitches. Emergency equipment in case of sickness or accident. First aid practice.

Summer Camp. Field and demonstration work; credit 1.

57. **Applied Forest Mensuration.** The scaling of logs, the determining of the volume of other forest products, and the reconnaissance of timbered areas. Complete reconnaissance of a specified area, including the running of primary and secondary base lines, the estimating and mapping of the timber by types, the making of contour maps, the writing of forest descriptions by watersheds, etc.

Summer Camp. Prerequisite 32; credit 5.

58. **Field Silviculture.** A continuation of 52. Forest types; factors determining each. Type mapping. Natural reproduction of the forest under varying conditions. Improvement cuttings. Marking timber for cutting with reference to the silvicultural systems.

Summer Camp. Prerequisite 52; credit 3.

59. **Wood Technology.** The structural and physical properties of economic woods in the United States and their identification. Detailed structure studied under compound microscope. Identification by physical and structural characteristics with the naked eye and by means of hand lens. Qualities, such as grain, texture, weight, color, hygroscopiscity, etc., as related to specific uses. Seasoning, warping, checking, shrinking, and imperfections in wood, with their causes and effects.

4th, 6th and 8th Sem. Recitation 1; labs. 2, 3 hr.; credit 3; fee $2.00.

60. **Woods Used in the Home.** The common woods used in the construction of the home. The identification, value, durability, and use of each. Woods used for fine finishing and furniture. Substitutes for valuable woods and how to detect them. The value of solid, veneered, quarter-sawed, and rift sawed wood for domestic use. How quartered and flat grain are produced. The defects of wood. The use of cheaper soft woods for interior finish for replacing the expensive hardwoods. For students in Home Economics.

Lecture 1 hr.; laboratory 2 hrs.; credit 1⅔ hrs.

61. **Forest Mapping.** A laboratory subject covering the field of forest mapping. Especial stress laid on topographic mapping and the symbols used in National Forest work; type maps, stand maps, reproduction and other maps will be made from field data collected during the preceding summer camp.

5th Sem. Laboratory, field, and office, 3 hrs.; credit 1.

62. **Commercial Woods.** An exhaustive study of the more important native and exotic species found on the markets and consumed in the wood using industries; the range, occurrence, stand, methods of logging and milling, drying, finishing, and value of the more important species. The physical and mechanical properties, the structure, and the adaptability and use of the more important woods for the various commercial purposes.

7th Sem. Lectures and recitations 2; credit 2.

63. **Lumber Markets.** Wholesaling and retailing of lumber. The wholesale markets; retail markets; exports and imports of lumber and other forest products; supply and demand; lumber prices; lumbermen's associations and other related work. Lectures and assigned readings.

7th Sem. Prerequisite, For. 54; recitations 3; credit 3.

64. **Lumber Transportation.** Lectures on lumber transportation; factors influencing methods of lumber transportation; freight rates and related matters.

7th Sem. Lecture 1; credit 1.

65. **Farm Forestry.** For agricultural students. General forestry and identification of forest trees; planting of trees as windbreaks for farmstead and crops; management and care of the farm woodlot; estimating amount and value of the products of the woodlot; identification, properties, and uses of commercial woods; seasoning and preserving posts and other timbers.

1st or 2nd Sem. Recitation 2; lab. 1, 2 hr.; credit 2⅔.

Botany 365. **General Forest Pathology.** Principles and practice in plant pathology as they are related to forest trees and their products.

7th Sem. Prerequisites 127 or 128 or 161, 268, 407; recitation 1; labs. 2, 3 hr.; credit 3; fee $3.00.

Botany 407. **Dendrology.** Families, genera, and species of the North American trees, beginning with the gymnosperms and ending with the angiosperms. A collection of thirty conifers and seventy deciduous trees will be required.

4th or 8th Sem. Prerequisite Bot. 161 or 127; recitations 2; labs. 2, 3 hr. in lab. and 1, 2 hr. in field; credit 4⅔; fee $4.00.

Chemistry 370. **Chemistry of Forest Products.** A brief outline of the chemistry of plant growth followed by a study of the preparation and utilization of the chemical products obtained from the forest.

6th Sem. Prerequisite 351; lectures 2; labs. 2, 2 hr.; credit 3⅓; deposit $7.50.

Chemistry 372. **Chemistry of Forest Products.** A continuation of 370.

10th Sem. Lecture and laboratory periods as arranged; credit 4; deposit $7.50.

Civil Engineering 406. **Surveying.** Pacing, ranging, chaining, uses of the forest service compass and other simple instruments. A good general foundation for the work of the following summer in camp.

4th Sem. Prerequisite, Math. 30; must be followed by C. E. 557 and 658; labs. 2, 3 hr.; credit 2; fee $2.00.

Civil Engineering 557. **Surveying.** The uses of the compass, level, transit, and plane table; angle measurement; traversing; leveling; U. S. land subdivision; retracement surveys; observations for meridian; taking topography; calculations and office work.

5th Sem. Prerequisite 406; must be followed by C. E. 658; recitations 2; labs. 2, 3 hr.; credit 4; fee $3.00.

Civil Engineering 658. **Surveying.** A continuation of C. E. 557.

6th Sem. Prerequistie 557; recitations 2; labs. 2, 3 hr.; credit 4; fee $3.00.

Civil Engineering 659. **Timber Testing.** Tests for the properties of timber as a structural material, and comparative tests of the different species. The methods used by the United States Forestry Products Laboratories will be used.

6th or 8th Sem. Recitation 1; lab. 1, 2 hr.; credit 1⅔; fee $4.00.

Economic Science 123. **Forest Economics.** Relation of forests and forestry to other industries—agriculture, manufacturing, commerce; the

problem of state ownership; the value of forest land; taxation of forest land; forest education.

5th or 7th Sem. Recitations 3; credit 3.

Zoology 336. **Forest Entomology.** Life histories and habits of the more important insects injurious to American forests and forest products. So far as possible the insects and their work will be studied in the field as well as in the laboratory.

6th or 8th Sem. Prerequisiite Zool. 304; recitations 2; labs 1, 2 hr.; credit 2⅔; deposit $3.00.

GEOLOGY

Professor Beyer, Engineering Hall, Room 304
Assistant Professor Galpin

For information concerning the Division of Engineering see page 61.

The work of this department is conducted by means of recitations, lectures, conferences, laboratory work, and field excursions. The student is thus afforded an opportunity to gain a familiarity with the principles and theories discussed in the leading text-books, and encouraged to test these theories and verify the principles.

Geological studies are designed to meet the requirements of students in civil engineering, students in the division of agriculture, students specializing in zoology and botany, students in mining engineering, those who expect to become mining geologists, and students taking Industrial Science courses.

Nearly every state and territory maintains a geological survey or mining bureau or both. The federal government maintains the Geological Survey and the Bureau of Mines. Mining and exploration companies and many of the leading railways include one or more geologists in their corps of expert advisers. Many high schools and most colleges and universities include geology in their curricula. The supply of well trained geologists never exceeds the demand.

The Department of Geology together with the Department of Mining Engineering occupies quarters in Engineering Hall. The working equipment consists of museum materials, field and laboratory instruments.

The museum contains carefully selected series of fossils, minerals, rocks, and ores, all available for study purposes. Among the more important collections are the educational series of rocks collected by the United States Geological Survey; the Smithsonian collection of rocks and minerals; the Krantz collection of about two thousand rocks and four hundred minerals; the Rohn, Hodson, and Young collections of rocks and ores from the Lake Superior region; the English mineral collection, containing two hundred specimens and one hundred and fifty species; the Baltimore series of more than two hundred specimens of rocks and minerals typical of the petrographic province of Baltimore; the Cushing collection from Clinton County, New York; a considerable amount of material to illustrate the physical features of rocks and minerals.

In paleontology, the most important collections are the Calvin collection of paleozoic fossils; a large collection of Coastal Plain fossils, principally from the Cretaceous of New Jersey, the Eocene of Alabama and Maryland, and the Miocene of Maryland and Virginia; the Permo-Carboniferous series from Kansas and Russia, and the coal plants of Iowa, Illinois, and Pennsylvania.

In applied geology the department possesses comprehensive series of lead and zinc ores with their characteristic gangue minerals from Joplin, Missouri, and from the Iowa-Wisconsin area; copper and iron from the Lake Superior region, Butte, Montana, Bisbee, Arizona, Brigham Cañon, Utah, and from the celebrated localities in the Ural mountains; copper, manganese, and silver from Butte, Montana; lead, silver, and gold from Colorado, Nevada, and California.

The laboratory is supplied with four Bausch and Lomb petrographical microscopes; one Fuess, medium model petrographical microscope; one Bausch and Lomb photo-micrographic apparatus for transmitted or inclined or vertically reflected light; one Bausch and Lomb binocular miscroscope for the examination of sands, drillings, etc., with camera; one Zeiss refractometer for determination of refractive indices of liquids; one Ward mineral dresser; one hand goniometer; one set Preston's celluloid crystal models; one set Krantz selected wood models, exhibiting complicated forms. The working equipment also includes one thousand thin sections of the common rock-forming minerals selected and arranged according to Rosenbusch, the collections selected to show the various representative characters of minerals and rocks; one section slicing machine; complete apparatus for mineral separations by heavy solutions; and apparatus for doing all kinds of photographic work. A considerable number of instruments for reconnaissance and field work in Geology are owned by the department.

The lecture equipment comprises a Hitchcock's geological map of the United States; one set of Kiepert's physical maps; numerous maps and charts of the United States Geological survey and of the Mississippi River commission; and an elaborate series of lantern slides and photographs.

Course in Industrial Science—Major Geology

For Freshman year see page 272, except that students shall complete eight credits in Chemistry.

SOPHOMORE YEAR

Third Semester	Credits[2]	Fourth Semester	Credits
Geol. 6[1]: Physiography	3	Geol. 1: General Geology	3
Chem. 157: Quantitative Analysis	4	M. E. 220: Projective Drawing	2
M. E. 121: Mechanical Drawing	2	Mil. 4: Military Drill	R
		Mod. Lang.: German	3

[1] The number refers to the description of the study.
[2] For definition of a credit see page 91.

Opportunity Comes Again

The College

The Iowa State College of Agriculture and Mechanic Arts conducts work along five major lines:

Agriculture	Home Economics
Engineering	Industrial Science
Veterinary Medicine	

The Graduate Division conducts advanced research and instruction in all these five lines.

Four, five, and six year collegiate courses are offered in different divisions of the College. Non-collegiate courses are offered in agriculture, engineering, and home economics. Summer Sessions include graduate, collegiate, and non-collegiate work. Short courses are offered in the winter.

Extension courses are conducted at various points thruout the state.

Research work is conducted in the Agricultural and Engineering Experiment Stations and in the Veterinary Research Laboratory.

Special announcements of the different branches of the work are supplied, free of charge, on application. The general college catalog will be sent on request.

Address HERMAN KNAPP, Registrar,
Ames, Iowa.

FARMERS' AND HOME-MAKERS' WEEK

JANUARY 28—FEBRUARY 2

For those who cannot attend any of the longer courses in agriculture or home economics, the college is planning its usual farmers' and home-makers' week. Last year it was attended by nearly 3,800 men, women, boys and girls. The instruction offered in that one week will deal with every phase of farm and home management. The coming short course will deal particularly with those problems of farm and home that are affected by war emergencies. Tuition for this will be free. Detailed circulars will be issued later.

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[2] For definition of a credit see page 91.

OFFICIAL PUBLICATION OF
IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS

VOL. XVI OCTOBER 31, 1917 NO. 22

Opportunity Comes Again

THIS is the story of an opportunity—a new opportunity.

That opportunity is for young men and women who, when the time for going to college came near, had to shut the door on ambition to get more education because it was not possible for them to leave the work they were doing.

To them Iowa State College of Agriculture and Mechanic Arts offers a new and special winter term of instruction which is complete in itself or may be made a part of a longer course. It is a "between seasons" term, opening November 12 and closing March 28, except for those who wish to continue until June and thus complete the college year. It will include courses in agriculture, engineering, home economics and industrial science. All four lines of work, both of freshman and sophomore grades, will be offered in the college proper. Courses of non-collegiate grade in general agriculture, fruit growing and gardening, herdsmen's training, home economics and vocational engineering will be offered to those who have not been able to go thru high school and who are over 17 years of age in the case of men and over 18 years in the case of women.

Advantages of the Winter Term

This special term exactly fits the needs of young men and women who cannot leave farm or other tasks in September. It begins after the heavy work of summer and fall is out of the way and it closes before the rush of spring work begins. It corresponds to the old-fashioned winter term of the district school of our fathers and grandfathers, which gave the big boys and girls a chance to go on with their schooling at a time when they were not needed for work on the farm or elsewhere. This new arrangement of the college gives the youth of today the same kind of an opportunity to get training for doing big things thru life,

Issued weekly. Entered as second class matter at Ames, Iowa, act of 1912.

except that it is as much better as the modern college is better than the old district school.

This special term also fits the needs of young men and women who must pay their own way, wholly or in part, if they would get more education. Never before in Iowa has just such an opportunity come knocking at their doors. It says to them that they may take full advantage of the season of profitable employment, earning and saving to the utmost when there is a chance to do it, and then, when the slack or idle season comes, enter college and go on with their schooling. It puts the possibility of college training within reach of many who have heretofore felt that they could not do both, earn and learn what colleges have to offer.

The work of this winter period will also fit exactly into the plans for completing a course in college. The subjects offered are all subjects for which credit will be granted toward a bachelor's degree in the case of the collegiate work, and toward a certificate in the case of the non-collegiate work. Moreover, the subjects are all fundamental, they come in their correct sequence, and they open up the way to subsequent studies in the various courses chosen by the student. There will be no loss of time nor confusion for those who enter for this term; every bit of work completed will count as it needs to count towards final completion of a technical course. Those who enroll as freshmen November 12 and continue their work until June will be able, with very little extra effort, to complete a full four years course in another three years, and sophomores, in two years more.

Plan of the Term

In the collegiate courses in agriculture, engineering, home economics and industrial science, it is planned to conduct the work of the special term in this manner: On entering November 12, which is midway along in the regular college semester, the student will classify for one-half of the full number of freshman or sophomore subjects, but he will do twice the customary work in each subject and thus have a full schedule. At the end of the first semester, January 25, he will have half of a full semester's credits, or about nine. Then the student has two options: He may choose to carry the full list of second semester subjects and continue them until June, or he may choose half of them, do intensive work as he did beginning November 12, and complete nine credits by March 28.

Tuition free: As in the case of all other instruction offered, tuition will be free to residents of Iowa. There will,

[1] The number refers to the description of the study.
[2] For definition of a credit see page 91.

of course, be the customary and necessary special fees for laboratory material and incidental costs, but those will be reduced proportionately to the length of the student's residence in college. Non-residents of Iowa will be expected to pay the usual moderate tuition fee.

Immediate Notice Necessary

It will be necessary for all students who expect to enroll for this special winter term to give notice of their intention on or before November 1. Otherwise they cannot be certain of acceptance. That notice should be sent to The Registrar and the post card form accompanying this booklet may be used. On receipt of such notice, The Registrar will give further instruction as to admission, which will be on the basis of the standard requirements of the college as to entrance credits as explained in its general catalog. The admission requirements for non-collegiate courses are explained later in this booklet. The Registrar will also explain how arrangments may be made for rooms and board in the dormitories in the case of the women, and outside in the case of the men.

THE COLLEGIATE COURSES

THE studies offered in the winter term for credit towards a degree of bachelor science in the various technical courses have been chosen carefully from the full list of freshman and sophomore studies. Each is fundamental and essential to work that follows later on. Together they put the short term student in a position of good advantage to complete a full four or five year course.

AGRICULTURE

Freshman studies: The freshman studies in agriculture offered in the special term include *chemistry*, which is an underlying science, and *animal husbandry* and *farm crops*, which are also fundamental. All are prerequisite for essential later studies. These studies will be required of all freshmen who expect later to do their major work in agricultural education, animal husbandry, dairying, farm crops and soils, farm management or horticulture. Freshmen who enroll for agricultural engineering will take the subjects listed with the engineering studies offered.

Sophomore studies: In the first nine weeks of the special term students entitled to do sophomore work in agri-

cultural education, animal husbandry, dairying, farm crops and soils, farm management and horticulture will carry *chemistry, animal husbandry* and *English.* For the remaining period of the special term, or of the college year, the studies taken will vary with the course and will be arranged for with the department concerned.

Forestry

Freshman studies: Freshmen in forestry entering for the special term will carry *chemistry, general forestry* and *mathematics* thru the entire term, all being fundamental and essential for further work.

Sophomore studies: For students entitled to sophomore standing, chemistry will be required. The remaining studies will be arranged for with the head of the forestry department.

ENGINEERING

Freshman studies: All freshmen in the courses in agricultural engineering, ceramics, chemical engineering, civil engineering, electrical engineering, mechanical engineering and mining engineering will carry *mathematics* and *chemistry;* in addition they will carry either a study in *shop* or *field work* or *drawing*, depending upon the course they are following. In architectural engineering freshmen will carry *mathematics, English* and two studies in *drawing.*

Sophomore studies: All students in engineering who are entitled to carry sophomore work will carry *mathematics* (*calculus*) and *English.* They will also carry *chemistry* except in the courses in civil and architectural engineering. Additional studies, *shop work, surveying, history of architecture* and others, will be carried according to the student's special course.

HOME ECONOMICS

Freshman studies: All freshmen in home economics will carry the following fundamental studies thru the special term: *Chemistry*, which is an underlying science, *home economics* and *English. Botany* may also be offered during the Christmas vacation to those who desire to take it at that time. *Physical culture* will be required of all students.

Sophomore studies: Students entitled to do work of sophomore grade in the special term will carry *home economics, English, chemistry* and perhaps one of the other underlying sciences, *botany* and *zoology.* Physical culture will also be required.

[1] The number refers to the description of the study.
[2] For definition of a credit see page 91.

INDUSTRIAL SCIENCE

Freshman studies: Those who enroll in industrial science courses as freshmen will choose studies from the following list: *Mathematics, chemistry, English* and *botany.*

Sophomore studies: Students entitled to carry work of sophomore grade will choose from the following list of subjects: *Mathematics, chemistry, English* and *botany.*

THE NON-COLLEGIATE COURSES

THE non-collegiate studies in agriculture, home economics and vocational engineering fit the needs of young men and women who want special education along one of these lines, but who have not had a chance to complete a high school course. They have been offered for some years as part of two-year courses with unusual success, but this is the first time that they have been offered in a special winter term beginning as late as November 12 and closing as early as March 28, before the rush of spring work is on.

The studies offered not only give intensive practical instruction which will be highly profitable even if the student should not return for more work later, but they also count toward the completion of a full two years' work and the securing of a certificate of graduation. Those who complete the winter term may take up work again next September, or in the following November or February.

Admission: Any man or boy over 17 years of age, and any woman or girl over 18, who has satisfactorily completed public school work of the eighth grade or its equivalent, may enroll for one of the non-collegiate courses. Graduates of accredited high schools are expected to enroll in the collegiate courses. On receipt of an application for admission (fill out the mailing card accompanying this booklet) The Registrar of the college will furnish further information and instructions and will also advise as to rooming and boarding places. No tuition will be required of residents of Iowa. Moderate laboratory fees will be charged for materials used.

Farm and Home Week: All students of the special winter term will have the privilege of attending the lectures, demonstrations and meetings of the big annual short course and state corn show at Ames for the farm men and women of Iowa, January 28 to February 2.

Each week of the winter term the student will have opportunity to attend various lectures and entertainments given under the auspices of the college. These will be of as much educational value in their way as the vork of the

class room. All students of the winter term will also enjoy the full privileges of the college swimming pools, gymnasiums and athletic grounds.

AGRICULTURE

The special winter term student will carry the following studies:

Animal judging: A study of types and market classes of animals, including judging and placing. The animals of the college herds and flocks will be used.

Animal feeding: A study of feed stuffs, the principles of animal feeding and the practical feeding, care and management of live stock.

Corn production: A study of methods of selecting, storing, testing and grading seed; planting, cultivating and harvesting; cost of production; marketing; insects and diseases; field study of corn; laboratory judging and market grading. The state corn show will permit the special study of corn from every county.

Dairying: A thoro study of the fundamental principles of farm dairying. Secretion and composition of milk; testing of dairy products; separation and care of milk and cream; cheesemaking, butter making and ice cream making on the farm.

Miscellaneous: In support of these four main subjects, the student will get instruction in farm engineering, carpentering or blacksmithing, the fundamental chemistry of animal feeds, animal products and soils, the botany of farm plants, and English as it applies to every day needs.

Gardening and Fruit Growing

For the first time, a special course in gardening and fruit growing will be offered during the winter term. It is intended to prepare greenhouse workers, vegetable gardeners and leaders for school garden and vacant lot garden work. The complete course will require a school year of study, and only one-half of the full work will be finished March 28, at the close of the winter term. However, this half year will be profitable in itself even tho the second half is not taken next winter.

Herdsmen's Course

For the first time also, a specialized one-year course for herdsmen is to be given. This instruction will be offered in two periods, the first from November 12 to Macrh 28,

[1] The number refers to the description of the study.
[2] For definition of a credit see page 91.

next, and the second from November, 1918, to March, 1919. During the time between these periods students will be expected to be in the employment of some reliable, modern breeder. This course is not intended for men who expect to operate farms, but for men who want to take positions as herdsmen with livestock breeding establishments.

HOME ECONOMICS

The course in home economics will include the following studies which will be of value to home makers, demonstrators, milliners and dressmakers, tea-room managers and teachers:

Food study and preparation: Skill and efficiency in handling materials, utensils, stores, fuels; systematic work in kitchen; origin and cost of fuels; food sources, classification, composition, cost and their function in the body; practice cooking.

Garment making and handwork: Fundamental stitches, darning and patching; use of sewing machine and attachments; making of several garments.

Textiles: Fabrics, their history and development; modern manufacture and uses; adulterations, grading and tests; study of samples, names, kinds, prices, widths, weaves.

Physiology and personal hygiene: Proper care of human body, clothing and surroundings; functions of human body and laws governing health.

Miscellaneous: Chemistry as applied to the household; English as related to the every day affairs of women; physical culture.

VOCATIONAL ENGINEERING

The winter term in vocational engineering will include courses in electrical engineering, mechanical engineering and structural engineering. They will meet the needs of young men who are engaged in the trades and desire to fit themselves for better positions.

The studies offered in the winter term in the various courses are much the same, because they are all foundation studies, essential to education along these lines. They include, with slight variation, *elementary chemistry, shop mathematics, elementary physics, shop drawing, wood shop work, foundry work, drawing as applied to buildings, English.*

Six Weeks Courses

In addition to the above regular courses in vocational engineering, six weeks short courses will open, dealing with the following subjects: *Tractors, automobiles, telegraphy and telephony.*

COMBINED AGRICULTURE AND HOME ECONOMICS

This course, also opening November 12, is intended for young women who are looking forward to operating or managing farms, to teaching agriculture and home economics in rural, grade and non-accredited high schools, or acting as club leaders and demonstrators. The studies taken will be chosen from the lists given under agriculture and home economics.

THE TIMES DEMAND MORE EDUCATED MEN AND WOMEN

IN offering such a special winter term for the first time in Iowa, Iowa State College believes that it is offering an unusual opportunity to Iowa young men and women. It feels that the times demand that every possible encouragement be given to those who want to go further with their education.

Young men and women who can take advantage of this new opportunity may feel assured that in getting additional education they are fulfilling a patriotic duty. It is the opinion of men and women of judgment and foresight, from President Wilson on down, that the war is creating in this country a shortage of men and women educated for leadership, just as it has done in the countries of Europe. Particularly in the fields of agriculture, of engineering, of home economics and industrial science is there a cry for specially trained workers. The demand cannot be fully met for years. Those who fit themselves now for the largest usefulness in those fields will serve both their country and themselves to the largest profit. Iowa State College has opened a way to such training that is so broad and free that no young man or woman with real ambition for an education can fail to follow it if he will.

FOR COMPLETE INFORMATION CONCERNING ANY OF THE COURSES HERE DESCRIBED, WRITE TO

THE REGISTRAR, AMES, IOWA

THE ENCLOSED MAILING CARD MAY BE USED

[1] The number refers to the description of the study.
[2] For definition of a credit see page 91.

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